DIGITAL ACCESS TO SCHOLARSHIP AT HARVARD
DASH.HARVARD.EDU

HARVARD LIBRARY
Office for Scholarly Communication

Fidelity Versus Flexibility: Effects and Moderators of Program Management Structures on Teacher and Student Outcomes in a Cluster-Randomized Trial

Citation

Quinn, David. 2016. Fidelity Versus Flexibility: Effects and Moderators of Program Management Structures on Teacher and Student Outcomes in a Cluster-Randomized Trial. Doctoral dissertation, Harvard Graduate School of Education.

Permanent link
http://nrs.harvard.edu/urn-3:HUL.InstRepos:27112715

Terms of Use
This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA

Share Your Story
The Harvard community has made this article openly available.
Please share how this access benefits you. Submit a story .

Accessibility

Fidelity versus Flexibility: Effects and Moderators of Program Management Structures on Teacher and Student Outcomes in a Cluster-randomized Trial

David M. Quinn

James S. Kim

Heather C. Hill

Ebony N. Bridwell-Mitchell

A thesis presented to the faculty of the Graduate School of Education of Harvard University in partial fulfillment of the requirements for the degree of doctor of education.

2016

© 2016

David M. Quinn

All Rights Reserved

Acknowledgements

I thank my adviser, Jimmy Kim, and my committee members, Heather Hill and Ebony Bridwell-Mitchell, for their feedback and guidance on this dissertation. This dissertation also benefitted from the planning and implementation work of Helen Chen Kingston, Kirsten Aleman, and Mary Burkhauser for Adaptive READS. The administration and collection of teacher surveys was made possible thanks to staff from CIS-North Carolina, including Janet Schwartz, Wakenia George, Libby Forrester, Laura Rosof, Jamila Perry, Tracy Tisdale, Meredith Richbourg, and Graham Brown. These chapters also benefitted from conversations and feedback from Andrew Ho, Celia Gomez, James Noonan, Steve Hoffman, Ann Mantil, Beth Schueler, Rebecca Unterman, and Catherine Snow. Finally, I thank the teachers, administrators, students, and families that participated in READS.

Contents

Abstract iii

Introduction: A Framework for Applying Findings from Randomized Trials to Educational Practice 1

Study 1: Scaffolding Fidelity and Flexibility in Program Implementation: Experimental Evidence from a Literacy Intervention 19

Study 2: The Effects of Program Management Approach on Teachers' Professional Ties and Social Capital: Evidence from a Randomized Trial 57

Conclusion 98

Appendix A. Selected Spring Teacher Survey Items.. 100
Appendix B. Alternative Modeling Strategies (Network Analyses) 103

References... 107

Abstract

The questions of how to improve educational practice at scale, and what role scientific investigation can or should play in that endeavor, have been central to the enterprise of education research since its beginning (Dewey, 1929). In one approach, researchers produce evidence regarding the effects of standardized instructional procedures on student learning, and then school- and district leaders manage teachers' faithful implementation of those procedures. In another approach, teachers are encouraged to use their expert judgment and flexibly apply research-based principles of effective instruction in order to meet students' unique learning needs. While these contrasting frameworks have each been influential in research and practice, little empirical work exists comparing the relative effectiveness of each of these approaches in advancing outcomes of interest in varying contexts.

In the two separate studies that comprise this dissertation, I analyze data from a school-level cluster-randomized trial in which schools were randomly assigned to implement READS – a summer literacy intervention for elementary school students that includes school-based and home-based components – under a fidelity or flexibility management approach. In the first study, I investigate – and find evidence consistent with – the hypothesis that the optimal approach to educational program implementation may be a scaffolded management sequence, in which implementers first develop proficiency with a program through a fidelity phase of management, and then make program adaptations under a flexibility management phase. The second study is motivated by the growing body of theoretical and empirical work demonstrating the numerous ways in which teachers' social capital affects school improvement efforts. In this study, I investigate the effects of management approach on outcomes related to teachers' social capital. I find that the flexibility approach caused participants to form more intervention-related consultation ties and caused them to consult more frequently about instructional adaptation, as opposed to implementation. At the same time, the expansion of participants' intervention-related networks under the flexibility approach may have been offset by participants' shrinking consultation networks in instructional areas unrelated to the intervention. Both of these studies have implications for research on how school improvement initiatives are introduced and managed.

A Framework for Applying Findings from Randomized Trials to Educational Practice

The questions of how to improve educational practice at scale, and what role scientific investigation can or should play in that endeavor, have been central to the enterprise of education research since its beginning. In his 1929 monograph *The Sources of a Science of Education,* John Dewey argued that science was essential for bringing effective instructional practice to scale and made the case against a popular notion of his day, that education was not a science but an art. After acknowledging that some gifted teachers do indeed achieve pedagogical excellence without the aid of scientific study, Dewey wrote that without science:

> …the successes of such individuals tend to be born and to die with them...the only way by which we can prevent such waste in the future is by methods which enable us to make an *analysis* of what the gifted teacher does intuitively, so that something accruing from his work can be communicated to others (p. 10-11).

Today, nearly 90 years after Dewey's monograph, most would agree that science is useful to improving educational practice, but the specifics of how science can best be directed toward the goal of improving educational outcomes at scale continues to be hotly debated. When the Institute of Education Sciences (IES) was created in 2002, an important piece of its mission was to accumulate "scientific evidence on which to ground education practice and policy" (IES, n.d.). When the IES expressed a preference for scientific evidence from a particular research method – the randomized controlled trial (RCT) – this reinvigorated at debate over how science should be used to improve educational practice. Some scholars criticize, or delimit the usefulness of, the RCT as a means of creating knowledge useful to educational practitioners.

In this introductory chapter, I sketch a framework for how research evidence can be used to improve educational practice at scale, and discuss the role of randomized trials as a particular method of collecting evidence on causal relationships important to education. This framework builds on Dewey's vision for the role of science in improving educational practice by incorporating scholarship that considers the particular ways in which evidence from randomized trials can be useful to practitioners. I then describe the two studies that comprise this dissertation and discuss the ways in which these studies fit within this framework.

Dewey's Vision for the Application of Science in Education

According to Dewey, science signifies "the existence of systematic methods of inquiry, which, when they are brought to bear on a range of facts, enable us to understand them better and to control them more intelligently, less haphazardly and with less routine." (p. 8-9). Such systematic inquiry "gives common efficacy to the experiences of the genius" (p. 11) by allowing the average teacher to understand and apply insightful discoveries from expert teachers and researchers. In other words, scientific investigation allows us to understand how and why some teachers are effective, which is a prerequisite for improving educational practices and outcomes at scale.

Dewey emphasized that the process of using science to improve practice is not one in which scientific methods are applied for the purpose of developing recipes for practitioners to follow. Scientific findings are not meant to yield inflexible rules to be uniformly applied. The reason is that “there is no educational practice whatever which is not highly complex; that is to say, which does not contain many other conditions and factors than are included in the scientific finding” (p. 19). For example, if a particular instructional technique is found to be effective in one study, this does not mean that the technique will be effective whenever or wherever it is adopted. A host of contingencies – including differing counterfactuals, differing school- and non-school contexts, differing teacher characteristics, and differing student characteristics – influence whether the findings from a particular study will replicate for a practitioner in a particular setting. According to Dewey, a practitioner who ignores these contingencies in favor of rigidly executing some set of scientifically-derived procedures is not appropriately using science to improve practice. Dewey makes the analogy of an engineer: “It is not the capable engineer who treats scientific findings as imposing upon him a certain course which is to be rigidly adhered to: it is the third- or fourth-rate man who adopts this course. Even more, it is the unskilled day laborer who follows it” (p 14). In other words, the education practitioner who blindly follows predetermined rules of practice is like the unskilled day laborer.

Instead, science is of value not because it can prescribe practice, but because it can inform practice. When educators are aware of scientific findings, their attention is alerted to observations that they otherwise might ignore, and they are able to interpret observations which they might have otherwise misunderstood or remained puzzled by. As such, science can “render practice more intelligent, more flexible and better adapted to deal effectively with concrete phenomena of practice." (p. 20). As scientific findings accumulate, they can eventually lead to the development of principles that connect and explain diverse and isolated facts. When practitioners understand such principles, they have a powerful tool for directing attention, motivating the collection of new information, interpreting and integrating separate observations, making sound judgments, designing solutions to instructional challenges, and guiding action in general.

To illustrate how science can be used by the educational practitioner, Dewey makes the analogy of a paint manufacturer who applies findings from laboratory chemists. Results in a factory setting, Dewey explains, vary from results in a laboratory setting by 20 to 200 percent. Nevertheless, the paint manufacturer would be making a mistake to ignore the laboratory findings, because the manufacturer's goal is to improve factory practices. Factory conditions involve more variables, which are harder to control, compared to the lab setting. The divergence of factory results from lab results is therefore a signal to the manufacturer to observe more closely in order to detect the variables that are affecting his or her results. As these variables are detected, the manufacturer accounts for them by adapting practice; with each adaptation, practice improves and the observations become subtler and the improvements more fine. If instead the manufacturer were to infer a fixed rule from the lab findings and follow the rule inflexibly, much less improvement would be made. In that case, the manufacturer may become frustrated by the discrepancy between the lab results and the factory results, and may conclude that the scientific findings are not applicable in the factory setting.

Goldenberg and Gallimore (1991) describe a similar process of how education practitioners might integrate local knowledge with research knowledge in order to improve learning outcomes for particular students. While the authors do not cite Dewey, their description aligns well with the vision that Dewey outlined. In the school described in Goldenberg and Gallimore's (1991) study, teachers believed, based on their local observations, that their kindergarteners who spoke Spanish at home were not ready to begin learning how to read and write. This prevented teachers from adapting instruction in order to help these students become readers. Scientific research on development and instructional effectiveness, however, suggested that their students were ready to learn how to read; after pacing conferences were instituted at the school, in which teachers met with a specialist to discuss student progress, teachers began to see the problem with students progressing at their current pace. The school culture began to shift, as teachers became inspired by this research knowledge to incorporate additional techniques from research into their practice and monitor the effects on student learning. Teachers took general principles from research, such as the idea that involving parents was important for student success, and the idea that both phonics and meaning have a role in reading instruction, and experimented with instantiations of these principles in order to determine which particular practices improved outcomes for their students.

The theory outlined by Dewey (1929), and the example provided by Goldenberg and Gallimore (1991), focus on the individual teacher as the consumer of educational science. At this level, the role of scientific inquiry is to develop a greater understanding of the variables and principles relevant to an individual teacher's classroom practice. In other words, the ultimate aim of this type of inquiry is to inform teachers who are asking questions such as "why am I seeing this set of educational outcomes for my students? How can I improve the learning outcomes of individual students?" Improving educational practice at scale, however, requires that teachers on the whole are systematically able to use scientific findings to develop effective answers to questions of this sort. This introduces a new set of questions into the science of education – questions about the variables and principles relevant to the management of instructional practice and the development of teacher human capital that will enable teachers to effectively use science to improve student outcomes.

Dewey's Vision and Instructional Management by Control versus Commitment

Rowan (1990) described two contrasting waves of school reform that appeared during the 1980s – the "control" approach and the "commitment" approach. Each approach involves different ways of organizing and managing the work of teachers, and each stems from a different set of assumptions about the nature of instruction. As such, each aligns with a different use of scientific research in education as described by Dewey.

In the control management wave of reform, policymakers addressed the problem of low student achievement by increasing the bureaucratic control over curriculum and teaching. This approach involves "the development of an elaborate system of input, behavior, and output controls designed to regulate classroom teaching and standardize student opportunities for learning" (p. 354). This approach in part grew out of research on direct instruction, which led some educators to believe that it was possible to achieve, with a relatively high degree of certainty, pre-specified educational goals through the implementation of prescribed, standardized instructional procedures. Given this assumption about teaching and learning, the goal of policymakers and education managers became that of constraining teachers to adhere to prescribed curricula and instructional methods. In this view, the role of education research was exactly what Dewey argued it should not be; that is, to discover what works in education for the purpose of providing sets of rules to be followed strictly by practitioners. In short, under the control management approach, the teacher plays the role of Dewey's unskilled day laborer.

The control reform movement was met with a backlash from scholars and practitioners who argued that this approach de-professionalized teaching and lowered teacher morale. In response, the "commitment" strategy to school improvement gained prominence. Advocates of this approach called for a decrease in bureaucratic control over the work of teachers in favor of a focus on creating the working conditions that promoted the development of teachers' expertise and their commitment to the profession. In contrast to the control approach, which viewed instruction as a set of tasks to be standardized, the commitment approach viewed instruction as a "nonroutine technology that relies on teacher judgement and expertise for its success" (p. 357). In this view, although instruction may be complex and nonroutine, it is nevertheless something that can be understood by expert teachers. Because it is not subject to prescription and standardization, it is not well-suited for the hierarchical management of the control approach; rather, teachers must be empowered to use their expertise to solve problems and adapt to the dynamic contexts in which learning takes place. This management structure is more aligned with Dewey's preferred mode of applying science in educational practice – that is, one in which teachers draw from scientific findings and scientifically-derived principles in order to guide their attention, observations, interpretations, and decision-making. In the commitment approach, the teacher plays the role of Dewey's "first rate engineer" rather than the unskilled day laborer.

Randomized Controlled Trials and Educational Improvement

Neither Dewey (1929) nor Rowan (1990) addressed specific questions about how different research methods might fit within the "standardization/control" framework or the "flexibility/commitment" framework. Yet, these frameworks raise an important question: "do different views on the way in which science should be used to improve education, and the instructional management systems that support these contrasting views, have implications for which research questions are pursued and which methods are used to answer them?" In this section, I discuss how the nature of one particularly prominent research method, the randomized controlled trial (RCT), has consequences for its relevance for each of these management frameworks.

In the context of educational research, a randomized controlled trial is an experiment, usually taking place in a field setting, in which some units (students, teachers, schools, etc.) are randomly assigned by the researchers to a "treatment group," which receives the treatment under investigation (e.g., some set of resources, or a certain kind of training, etc.). The other units participating in the study are randomly assigned to a "control group," which receives some alternative set of experiences. In many cases, the control group experiences "business as usual," or whatever they would be experiencing had they not been participating in the study. In such a scenario, the researchers are testing how the treatment compares to standard practice in that particular setting. Other times, researchers may be interested in comparing the treatment to some alternative treatment, or may randomly assign units to one of two or more possible treatments, and compare these treatments to each other, as well as to a business as usual control condition. In any case, what distinguishes an RCT from other quasi-experimental designs is that the researcher is the source of the exogenous variation in who receives which educational experiences.

Today, RCT is often described as the gold standard for education research. Advocates for the RCT often point to the important advancements the method has been responsible for in the fields of agriculture and medicine; applying RCTs in education, the argument goes, will enable analogous improvements in educational practice (Murnane & Nelson, 2007; Slavin, 2002). Given the prominence of randomized trials in educational practice today, it is worth examining how they fit into a broader framework on the role of science in improving educational practice and the way in which contrasting instructional management approaches support that role.

The benefit of the randomized trial is clear: it is the best way to obtain internally valid answers to descriptive causal questions – that is, questions of the form, "Does X cause Y?" RCTs are able to support causal inferences because the randomization of units to conditions means that, in expectation, the future outcomes of each group would be equal had it not been for the differences in experiences induced by the researchers. In other words, random assignment ensures that there are no systematic differences across groups at the start of the study; as such, any differences in outcomes after the intervention can be reasonably inferred to be the consequence of the treatment under study.[1]

As with any method, of course, the RCT has its limits. For example, RCTs are not suited for answering explanatory causal questions – that is, questions of the form, "*Why* does X cause Y?" (Maxwell, 2004; Shavelson & Towne, 2002). Yet even when restricting attention to descriptive causal questions, there are limits to the types of educational practices that are conducive to study by RCT.

Murnane and Nelson (2007) argue that randomized trials are helpful in building knowledge when the following conditions hold: 1) the treatment is well-defined, 2) the treatment is easy to implement and well-controlled, 3) the effects of treatment are detectable relatively quickly, and 4) treatment effects do not vary across many subgroups. The first two of these criteria require that the intervention being studied has well-specified routines that are adhered to with fidelity of implementation. The scope of interventions that are well-suited for RCT is therefore inherently limited, as many human endeavors involve activities that are not easily standardized and routinized. Activities that require adaptive thinking, judgment, and creative problem-solving cannot be pre-specified and packaged as a "treatment" out of context. To the extent that instructional activities can be standardized and pre-specified, randomized trials can be helpful in studying their effects. Outside of such activities, however, randomized trials are less helpful.

---

[1] There are, of course, threats to internal validity that can arise over the course of an experiment, such as differential attrition. Additionally, through bad luck, random assignment will sometimes result in groups that are not in fact equivalent at baseline. These are issues which must be addressed by the researcher, but which can be ignored for my purposes here.

As described above, the types of educational practices or programs that are well-suited for RCTs are the types of practices that fit within the "standardization/control" approach to educational management outlined earlier. These concepts are easily combined into a system in which researchers use RCTs to determine which sets of standardized instructional procedures are most effective at achieving pre-specified educational outcomes, and then decision-makers in the field of education (e.g., district leaders, school administrators, etc.) enforce teachers' adherence to these practices.

Given the types of educational practices for which RCTs are well-suited, Murnane and Nelson (2007) argue that evidence from RCTs is most likely to be useful toward improving practice within low performing schools rather than within schools that have already achieved some success. In a low performing school with no coherent improvement strategy, the adoption of standardized, evidence-based procedures may lead to an improvement over current practice. In a school that is already exhibiting satisfactory performance, however, improvement beyond current performance will likely require attention to the non-routine aspects of educational practice that defy standardization. That is, improvement in such a school will require that practitioners find solutions to the school's specific problems of practice; it will require individualized diagnosis and prescription, which cannot be accomplished by sticking closely to instructional regimes of standardized procedures. For schools like this, teachers are likely to be seeking answers to finer-grained causal questions compared to those being asked in control management settings. In control management settings, school leaders ask questions about which packaged instructional programs they should adopt and implement faithfully. In commitment management settings, teachers ask more specific questions about the best way for students with specific profiles to master specific skills. Although RCTs of packaged instructional regimes may not be particularly useful in commitment management settings, RCTs can (though less often do) address finer-grained questions useful in these settings.

How RCTs might fit within Dewey's Vision

Ball and Cohen (1999) describe a process of school improvement that aligns well with Dewey's vision for how science should be used to improve practice. In Ball and Cohen's (1999) vision, teachers collectively engage in an inquiry cycle in which they: 1) identify problems of practice connected to student learning, 2) identify the learning they as teachers need in order to solve the problem of practice, 3) seek out those learning experiences and experiment until they have solved the problem of practice, and 4) move on to a new problem of practice. We can see how Dewey's preferred mode of using science to guide practice applies to the first step in this process, by directing teachers' attention to potential problems and helping them identify variables that may be relevant to understanding the problems. Next, in the stage of identifying and seeking out learning, teachers first draw from existing research and then experiment locally by applying these research-based principles and adapting them as necessary based on feedback from the local context. The research that teachers will want to draw from will be research that presents evidence on cause-and-effect relationships. As discussed above, schools that are seeking to improve the non-routine aspects of instruction in this way are schools that have established some baseline level of effectiveness and are capable of operating in this commitment management framework. Consequently, the black-box program evaluation RCTs do not provide the type of causal evidence that is useful to them.

When engaging in an improvement process like the one described by Ball and Cohen (1999), teachers and school leaders will likely identify many variables that need attention and many actions they will need to take, toward different ends, in order to improve educational outcomes. An individual school will be able to better tailor an improvement effort by understanding discrete cause and effect relationships about a variety of outcomes and mediators, and then compiling their improvement strategy by assembling the actions that affect the mediators and outcomes they have identified as needing attention in their context. Ultimately, the outcomes of interest are student outcomes, but practitioners may have a more immediate concern to affect proximal outcomes, such as teacher learning, as part of a broader school improvement strategy.

As an example of how evidence from RCTs might be useful for schools showing adequate performance, imagine a school in which students are performing satisfactorily, but the school's algebra teachers are concerned that students are simply memorizing algorithms. Students are answering questions correctly on tests, but they are not developing a deep understanding of the material. Teachers look for research on ways that they might be able to help students develop deeper understanding, and uncover evidence from randomized trials on the effectiveness of worked example pairs (WEPs) in algebra (e.g. Rittle-Johnson & Star, 2007). The teachers decide to try the approach with their students, so they begin collaboratively planning WEPs to use with their algebra lessons and tracking students' progress in order to evaluate the effectiveness of their new strategy.

In addition to seeking out causal evidence on discrete instructional techniques such as WEPs, schools interested in commitment management and Dewey's vision of science will need evidence relevant to the process of enabling teachers to effectively use scientific findings to improve their everyday practice, and relevant to establishing the organizational and cultural supports that promote teachers' flexible application of science. For example, imagine a school's administrative team comes to the conclusion that students are having a hard time transitioning from one grade to the next due to a lack of coordination of curriculum across grade levels within the school. The administrative team decides that teachers across grade levels must come together to plan collaboratively on how to improve this transition, but norms of independence and privacy at the school are strong and teachers are resistant to collective decision-making about classroom practice. In this case, the leadership team would be looking for causal evidence on specific strategies that will build a productive collaborative culture. Currently, evidence from randomized trials on a question such as this is harder to come by.

Scaffolding Dewey's Vision

The standardization/control approach and the flexibility/commitment approach make different demands on practitioners. In the control approach, the teacher's job is to achieve some implementation ideal; in other words, to follow some instructional recipe as closely as possible. Teachers are not expected to diagnose, prescribe, design, or innovate. Given that job tasks are pre-specified, there is little need for teachers to share innovations with one another or engage in group problem-solving or decision making. Consequently, this approach typically lacks collaborative work structures or learning experiences. In contrast, teachers under the commitment approach to instructional management must be able to recognize what is working and what is not working about an intervention. When something isn't working, teachers must determine why, devise solutions, test those solutions, and repeat the process as needed. This requires deep instructional knowledge and the ability to flexibly apply findings from science. The approach also benefits from more collaborative work structures, given the increased potential payoff of teachers exchanging information about innovations and of engaging in group problem-solving (Elmore, 1996).

Theory therefore suggests that the success of a commitment or control approach to management will depend on the knowledge and skill of teachers as well as the support structures in place for those teachers (Rowan, 1990). A Vygotskyan perspective (Vygotsky, 1978) suggests that these management approaches may be organized into a scaffolded sequence, in which teachers first build their skills within the structures of a control management approach, and then graduate to a commitment management approach once they are prepared to flexibly apply the principles they learned in the control management phase. (McMaster et al., 2014; Slavin, Madden, & Datnow, 2007). Returning to Dewey's analogy, the unskilled day laborer develops a deeper understanding of engineering principles through the process of following prescribed rules; once achieving that greater understanding, the laborer can begin applying those rules with more flexibility and creativity.

This Dissertation

This dissertation is comprised of two studies from a randomized trial that should be understood within the broader framework discussed in this introduction. Both studies present evidence related to the management approach taken to instruction (i.e., the control versus commitment approaches).

The first study, entitled "Scaffolding Fidelity and Flexibility in Program Implementation: Experimental Evidence from a Literacy Intervention," is concerned with the process of how a school achieves Dewey's vision of flexible use of scientific findings. This study tests hypotheses regarding the process of scaffolding Dewey's vision. As discussed above, in the control approach to instructional management, schools adopt evidence-based programs and strive to implement them with fidelity. Alternatively, the commitment approach assumes that the process of scaling up effective instructional practice should be a flexible one in which practitioners adapt findings to local contexts. Theory suggests that the optimal approach may be a scaffolded management sequence, in which implementers first develop proficiency with a program through a fidelity phase of management, followed by a flexibility phase in which implementers make adaptations. Using data from a cluster-randomized trial in which schools were randomly assigned to implement a fidelity or flexibility version of a literacy intervention, this study finds support for the scaffolded hypothesis. The effects of program management strategy on teacher and student outcomes depended on teachers' prior experience level with the intervention.

In the second study, entitled "The Effects of Program Management Approach on Teachers' Professional Ties and Social Capital: Evidence from a Randomized Trial" I present causal evidence regarding the effects of instructional management approach on teacher social capital outcomes. The focus on social capital is motivated by a growing body of theoretical and empirical work on the numerous ways in which teachers' social capital affects school improvement efforts. Social ties are prerequisite for social capital, yet little evidence - and none from randomized trials – exists on how malleable factors, such as the way in which teachers' work is managed, affect teachers' social ties and social capital. In this study, I use data from the same cluster-randomized trial as the first study. I apply a decision-making perspective on tie formation (Nebus, 2006) to investigate the effects of program management strategy on teacher social capital-related outcomes. The fidelity management approach caused participants to form more intervention-related consultation ties and caused them to consult more frequently about instructional adaptation, as opposed to implementation. At the same time, the expansion of participants' intervention-related networks under the flexibility approach may have been offset by participants' shrinking consultation networks in instructional areas unrelated to the intervention. Within the framework presented above, this study provides results that inform the flexible use of scientific findings by school leadership teams that are interested in introducing a new instructional initiative under a commitment management approach and are concerned about what the effects may be on teachers' social capital. In other words, the results of this study serve to guide practitioners' attention to variables in their settings that may be relevant to the school improvement goals.

Scaffolding Fidelity and Flexibility in Program Implementation: Experimental Evidence from a Literacy Intervention

An important and enduring question in education research is that of how effective instructional practices can be brought to scale (Coburn, 2003; Elmore, 1996). A common framework for scale-up today is that of the "linear model" of scientific research (Coburn & Stein, 2010). As applied to education, the linear model describes a sequence that begins with basic research conducted in the social science disciplines, followed by applied research motivated by problems of educational practice, which eventually leads to the codification of professional knowledge and the dissemination of best practices. Often, these practices take the form of educational programs, or "set[s] of replicable instructional events" (Popham, 1967, p. 402). The programs that are shown through research to have positive effects for students become candidates for scale-up. This has been the model championed by the Institute of Education Sciences since 2002 (Coburn & Stein, 2010).

A key concept related to the linear model in education research is that of program implementation fidelity. In the applied research phase, it is only meaningful to measure the effect of an educational treatment if that treatment is well defined and if the treatment is administered faithfully (Dane & Schneider, 1998; Dusenbury Brannigan, Falco, & Hansen, 2003; Murnane & Nelson, 2007). When studies indicate that a program has positive effects for students, practitioners are encouraged to implement the program with fidelity because it was under this condition that the positive effects were observed (Dusenbury et al., 2003;

LaChausse, Clark, & Chapple, 2014).

However, success stories from the program fidelity approach to scale-up are somewhat rare, as programs that show promise during initial efficacy trials often fail to replicate positive effects in large-scale effectiveness studies (Coalition for Evidence-based Policy, 2013). This may happen for a variety of reasons. First, counterfactuals vary across contexts, and any given intervention may not be superior to all business-as-usual practices. Secondly, the instructional practices that comprise a program may only be effective for students with certain characteristics or in certain contexts; or perhaps only certain teachers, in certain contexts, are able to effectively implement these programs (Slavin, 2002). The fact that educational settings can vary so widely has led some to the conclusion that it is neither feasible nor desirable to implement instructional procedures with fidelity across contexts (Dane & Schneider, 1998; Dusenbury et al., 2003).

Two Approaches to Instructional Management: Fidelity of Implementation versus Flexible Implementation

As an alternative to the fidelity approach to instructional scale-up, some scholars argue that educational treatments need not be thought of as recipes to be strictly followed; rather, bringing a program to scale may be more a process of instituting practices across schools that bear a “family resemblance” with one another (Elmore, 1996). In this conception, scaling up educational treatments requires balancing program fidelity with program adaptation (Castro, Barrera, & Martinez, 2004; Dane & Schneider, 1998; Ferrer-Wreder, Adamson, Kumpfer, & Eichas, 2012; McDonald, Keesler, Kauffman, & Schneider, 2006; McLaughlin, 1990; US Department of Health and Human Services, 2002). According to this conception, programs may have the best chance of improving educational outcomes at scale if the “core components” of the program are kept intact, while practitioners adapt the intervention so as to make it more compatible with their context (Castro et al., 2004; Ferrer-Wreder et al., 2012; McDonald et al., 2006; McLaughlin, 1990).

The “fidelity of implementation” and the “flexible implementation” models of instructional management make different demands on the practitioners implementing the program. In the fidelity approach, the teacher’s job is to achieve the program ideal envisioned by the program developers; in other words, to follow the instructional recipe as closely as possible. Teachers are not expected to diagnose, prescribe, design, or innovate. This approach lends itself well to what has been called the “control” approach to instructional management (Rowan, 1990), in which the teacher’s instructional tasks are predetermined and well-defined, and the administrator’s role is to ensure that the teachers execute those tasks. Given that job tasks are prescribed, there is little need for teachers to share innovations with one another or engage in group problem-solving or decision making. Consequently, this approach typically lacks work structures or learning experiences that are collaborative in nature. Under a fidelity approach, the types of learning experiences that support teachers’ implementation more often follow the traditional workshop model of professional development, in which the goal is for teachers to learn program-specific procedures and the importance of implementing them faithfully (LaChausse et al., 2014).

In contrast, teachers under the flexible implementation approach to instructional management must be able to recognize what is working and what is not working about an intervention. When something isn't working, teachers must determine why, devise solutions, test those solutions, and repeat the process as needed. This requires more from the teacher in terms of critical thinking and knowledge about the instructional theory of the program. Without deep knowledge of the program, teachers cannot make adaptations that are consistent with the program theory, so they are unlikely to improve the program (Penuel, Gallagher, & Moorthy, 2011). In the worst case, teachers' adaptations may even be harmful (McLaughlin & Mitra, 2002). The flexible approach also calls for more teacher autonomy over instructional practice (as opposed to administrator control) and for collaborative work structures, given the increased potential payoff of exchanging information about innovations and of engaging in group problem-solving (Elmore, 1996). As such, learning experiences built around peer collaboration and experimentation may be more useful for teachers under the flexibility approach.

Fidelity and Flexibility as a Scaffolded Sequence

The distinct demands made of teachers by the fidelity and flexibility management approaches, and the contrasting work structures that support teachers in meeting those demands, suggest that these management regimes may be better-suited for different sets of circumstances (Berman, 1980). Teachers with less curricular knowledge may perform better under a stricter fidelity approach, while more experienced or effective teachers may be capable of improving the program under the freedom offered by a flexibility approach. Furthermore, skilled teachers who are used to making instructional decisions can sometimes feel frustrated by rigid implementation requirements, making the fidelity approach a poor fit (Meyer, Miller, & Herman, 1993; Murnane & Nelson, 2007; Rowan, 1990).

A Vygotskyan perspective (Vygotsky, 1978) would suggest that organizing these management approaches into a scaffolded sequence may optimize results. Some researchers have proposed that teachers who are new to an intervention should implement the program with fidelity until they understand how the various components work together as designed and are able to execute them proficiently. After this period of fidelity, teachers will be prepared for flexibility management because they will possess the foundational knowledge and skills necessary for designing and executing effective adaptations (McMaster et al., 2014; Slavin, Madden, & Datnow, 2007). However, no experimental studies have directly tested this model.

Focus, fiddle, friends. Frank and colleagues (Frank, Zhao, Penuel, Ellefson, & Porter, 2011) devised the mnemonic "focus, fiddle, friends" to describe a scaffolded learning process for teachers that is relevant when thinking about fidelity and flexibility. According to this progression, teachers who are unfamiliar with a particular educational approach first learn about the approach through *focused* professional development and direct instruction. This enables teachers to develop an understanding of an educational program and its theory of action, and achieve a basic level of implementation. Teachers then *fiddle* with these techniques by experimenting with variations on the techniques in order to determine what works best for them and their students. Through this process, teachers develop specific and high-level questions, requiring them to receive expert assistance from experienced *friends* (colleagues). Such discussions with colleagues also help to spread adaptive innovations and keep the program active.

Frank et al. (2011) tested this model using data from schools in which teachers were being encouraged to incorporate computer technology into their classroom instruction. Consistent with the model, the researchers found that teachers who were initially infrequently using computer technology experienced greater implementation gains when they received focused professional development on technology use. Teachers who were initially at medium levels of implementation benefitted most from having opportunities to experiment with the technology, while teachers initially at a high level of implementation benefitted from interacting with colleagues about computers (though the highest-level implementers experienced implementation gains from all types of learning experiences). The authors suspected that *fiddle* experiences may be more effective when they followed *focus* learning experiences, but were unable to empirically test this.

Differentiated Learning within the Scaffolded Sequence

The results of the Frank et al. (2011) study suggest that teacher learning and program implementation may be optimized when management structures are differentiated according to teachers' intervention-related experience or knowledge. Such differentiation fits well with the model of fidelity and flexibility as a scaffolded sequence. In Figure 1, I merge these ideas into a graphical conceptual model.

As seen under the "Phase 1" heading of Figure 1, when schools initially adopt an intervention, teachers experience a period of fidelity management, in which their primary intervention-related learning comes through explicit instruction on how to implement the program faithfully. These *focused* learning experiences enable new teachers to internalize the program theory and achieve basic proficiency with the instructional procedures as designed by the program developers (the Phase 1 proximal outcome).

<Insert Figure 1 about Here>

After teachers develop sufficient mastery of the program, they are ready for the second phase, in which program management transitions into a flexibility approach. In this phase, teachers collaboratively (i.e., with “friends”) design adaptations (“fiddle”) that they believe will make the program more effective for their students. Through these *fiddle* and *friends* learning experiences, teachers acquire a deeper understanding of the program and how its active ingredients interact with their context, which enables teachers to more successfully incorporate the program techniques into their classroom practice (Phase 2 proximal outcomes).

During the flexibility phase, one source of teacher learning may be peer effects facilitated through the collaborative implementation structures. That is, individual teachers may have greater success with the program when their collaborators are more expert with the program (Jackson & Bruegmann, 2009) because more expert teachers are more likely to accurately diagnose program difficulties, design solutions to share with colleagues, and provide colleagues with high quality feedback.

Finally, teachers’ experimentation with program adaptations leads to an enacted program that fits better with their context. The greater tailoring of the program to the context then leads to the distal outcome of improved student learning.

The Present Study and Research Questions

In this study, I analyze data from a randomized trial of READS for Summer Learning, an evidence-based literacy program for elementary school students, in which schools were randomly assigned to implement the program under a fidelity approach to program management ("Traditional READS") versus a flexibility approach ("Adaptive READS"). In other work, we examine the main effects of management structure, and report a positive main effect of Adaptive READS (compared to Traditional READS) on student reading comprehension (Kim et al., in preparation). In the present study, my primary objective is to test the hypothesis that a scaffolded management sequence optimizes teacher learning, changes in practice, and ultimately, student learning. I do this by exploiting exogenous variation in teachers' prior participation in Traditional READS. Specifically, I examine whether the effects of the flexibility condition differ depending on whether the teacher had, through random assignment, participated in Traditional READS in the past. Additionally, I seek to understand whether peer effects facilitate teacher learning under the collaborative structures of the flexibility approach. Understanding how contrasting program structures may interact with characteristics of teachers and schools will help education researchers, decision-makers, and practitioners design effective adoption processes for school improvement efforts.

I ask the following research questions:

- Does the intervention management approach (i.e. fidelity versus flexibility) affect teachers' intervention-related learning?
    - Do effects differ depending on teachers' past intervention experience or teachers' peers' intervention experience?
- Does the intervention management approach affect teachers' incorporation of intervention techniques into their regular classroom practice?
    - Do effects differ depending on teachers' past intervention experience or teachers' peers' intervention experience?
- Does the effect of intervention management approach on student reading comprehension differ depending on the teacher's prior experience with the intervention?

Methods

Procedures

READS for Summer Learning. READS for Summer Learning is a program designed to narrow income-based reading skill gaps among elementary school students. In this study, I compare two versions of READS executed over the 2014-2015 school year and summer of 2015: Traditional READS and Adaptive READS. Traditional READS is an evidence-based program (Guryan, Kim, & Quinn, 2014; Kim, Guryan, White, Quinn, Capotosto, & Kingston, 2016; White, Kim, Kingston, & Foster, 2013) representing a fidelity approach to management, in which teachers receive training and resources to support their adherence to researcher-designed program procedures. Adaptive READS takes a flexibility approach by having teachers work collaboratively with their grade-level teams, with guidance from researchers, to adapt READS in ways they believe will increase its effectiveness for their students. In Figure 2, I contrast the main components of Traditional and Adaptive READS.

<Insert Figure 2 about Here>

Traditional READS. Students in Traditional READS receive eight books in the mail over summer vacation, which are matched to their reading level and interests. Each book includes a "tri-fold" (or paper folded into thirds) 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, which focuses students' attention on important text structures, and a post-reading comprehension check. Students are expected to mail back completed tri-folds (with postage prepaid).

Traditional 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 the summer activities. 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, parents 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 books to students. Prior to summer break, students receive copies of the two books used in the end-of-year lessons. Over the summer, the families of students who do not return tri-folds receive phone calls with reminders and inquiries about additional support they may need in order to complete the tri-fold activities.

Adaptive READS. In keeping with previous research suggesting that teachers must understand a program's theory in order to make productive adaptations (Penuel et al., 2011), 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 (Traditional) READS implementation (e.g. data on tri-fold return rates and RFN attendance) and examined these data with their grade-level teams to develop hypotheses about ways the program may be improved in their school. After this initial meeting, teachers could elect to earn district professional development credit by completing six online modules in December designed to teach them more about the research-based principles underlying READS (81% of teachers surveyed in the spring participated in the modules). Teachers then attended two additional formal meetings – one in January and one 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 revising students' suggested book lists based on teachers' individualized information about students, revising the lesson scripts, developing new strategies to better scaffold the summer reading process, developing strategies to strengthen the home-school connection, or providing additional incentives or summer follow-up activities to encourage tri-fold returns.

In Adaptive READS, teachers received a $600 stipend; in Traditional READS, teachers received $300.

Setting, Design, and Participants

In Figure 3, I present a graphic illustrating the random assignment procedures and their implications. In the school year prior to the present study (named "Year 1," the 2013-2014 school year), teachers in participating elementary schools were randomly assigned within school to a treatment group that implemented Traditional READS, or to a business-as-usual control condition. From this set of Year 1 schools, 27 high-poverty schools from seven North Carolina school districts were recruited to participate in Year 2, over the 2014-2015 school year. Recruited schools were matched within district based on school poverty level and performance on the state standardized test. Within each matched pair (or triad), one randomly-selected school was assigned to Adaptive READS for the 2014-2015 school year (Year 2); the other schools were assigned to a second year of Traditional READS. All fourth grade teachers at each school were required to participate in their school's version of READS for Year 2. Because random assignment to Traditional READS (versus control) happened within school in Year 1, some teachers in Year 2 had randomly participated in Traditional READS in the past. As illustrated in Figure 3, control teachers in Year 1 ended up with either one year of Traditional or one year of Adaptive READS at the end of Year 2. Treatment teachers in Year 1 ended up with either two years of Traditional READS or one year of Traditional READS followed by one year of Adaptive READS (i.e., the scaffolded sequence). In both conditions, all teachers in Year 2 (regardless of prior experience) were required to participate in that condition's learning structures (i.e., all Traditional teachers in Year 2 participated in lesson training and all Adaptive teachers in Year 2 participated in the working group meetings). The theory introduced earlier predicts that among teachers who were new to READS in Year 2, Traditional READS will be more effective; among teachers with previous (Traditional) READS experience, the scaffolded sequence of Traditional followed by Adaptive will be more effective than two years of Traditional.

<Insert Figure 3 about Here>

Measures

Teachers completed a web-based survey in the spring of 2015 with questions about their intervention experiences. The survey included original items and items adapted from previously-validated surveys. In developing the survey, we went through several rounds of review with external experts and piloted the items with teacher consultants (see Appendix A for text from selected survey items).

Teachers' literacy-related learning. We measured teachers' literacy-related learning in areas related to the intervention with an index created by averaging five survey items (α=.84) and standardizing those averages to a mean of 0 and standard deviation of 1. Items comprising the index were presented to teachers following the introduction, "In this set of questions, we'd like you to think about your literacy-related learning this school year. This learning could have taken place in any setting." Teachers were then asked several questions with the stem "How much did you learn this school year about each of the following?" The areas teachers were asked about were areas related to the READS components: "matching books to students for independent reading," "teaching students a reading comprehension routine," "engaging students' families in student literacy," "supporting students' independent reading," and "increasing students' engagement in reading." Answer choices were "nothing," "very little," "some," "quite a bit," and "a tremendous amount," which were scaled from 0 ("nothing") to 4 ("a tremendous amount"). A principal components analysis revealed only one component with an eigenvalue above one, which positively weighted all items. For interpretive clarity, I present the results using the mean-based index, but results replicate with a PCA-derived index.

READS-related literacy activities in teachers' regular classroom practice. I created a scale to measure changes in teachers' literacy practices by averaging teachers' responses on five relevant survey items (α=.85) and standardizing the index to a mean of 0 and standard deviation of 1. Teachers were asked a series of questions about the extent to which they incorporated new literacy strategies or followed READS-based principles in their regular classroom instruction (i.e. outside of READS). The areas asked about were the same five areas described above for teachers' literacy-related learning, and READS was not explicitly referenced as a source of the change in practice. For example, one question asked, "This school year, to what extent did you incorporate new strategies for supporting students' independent reading into your regular classroom practice (i.e. outside of your planned READS activities)?" Answer choices were "not at all," "very little," "some," "quite a bit," and "a tremendous amount," again with scores ranging from 0 ("not at all") to 4 ("a tremendous amount"). A principal component analysis revealed only one component with an eigenvalue over one, which positively weighted all items. Again, I present analyses using the mean-based index, but results replicate with the PCA-derived index.

Student reading comprehension. Students took the Iowa Test of Basic Skills (ITBS) reading comprehension assessment in fall of 2015 as a posttest. I use the ITBS developmental standard score metric, standardized to a sample mean of zero and standard deviation of one at each wave in order to allow the treatment effect coefficient to be interpreted as an effect size.

Analytic Plan

Teacher Outcomes.

To test for Adaptive-Traditional differences on teachers' literacy-related learning and classroom literacy practices, I fit OLS regression models of the form:

$$Y_{is} = \beta_1 ADAPTIVE_s + \beta_2 EXP_i + \sum \beta_k x_s + \epsilon_{is} \quad (1)$$

where Y_{is} is the standardized index score for teacher *i* in school *s* on either the learning index or the classroom practices index, *ADAPTIVE* is a binary indicator variable expressing whether school *s* was randomly assigned to the Adaptive READS condition, *EXP* is a binary indicator expressing whether teacher *i* had prior experience implementing the READS intervention, and x_s is a set of dummy variables indicating to which randomization bloc school *s* belonged. Standard errors are clustered at the school level to account for residual dependence within schools.[2]

In order to test whether the effect of Adaptive READS differed for teachers with and without prior READS experience, I added an interaction term to model 1:

$$Y_{is} = \beta_1 ADAPTIVE_s + \beta_2 EXP_i + \beta_3 (ADAPTIVE_s \times EXP_i) + \sum \beta_k x_s + \epsilon_{is}\,, \quad (2)$$

where all other terms are as defined above. To test whether the effect of condition differed depending on the extent to which teachers' peers were experienced with the intervention, I added to model 1 the interaction between *ADAPTIVE* and the number of teacher *i*'s READS team colleagues who had prior experience with READS, the main effect of the number of other teachers with READS experience, and the main effect of the total number of teachers on the READS team in school *s*.

---

[2] My clustering method accounts for small school-level sample sizes. I also fit multi-level models with random intercepts for schools as sensitivity analyses; all conclusions are unchanged.

Effects on student reading comprehension. As noted above, elsewhere we report a significant positive main effect of the Adaptive condition (compared to the Traditional condition) on student reading comprehension (Kim et al., in preparation). In the present study, my interest is in whether the effect of Adaptive READS on student reading comprehension differed depending on teachers' prior experience with READS. I use OLS regression to model the fall ITBS score of student *i* in teacher *t'*s classroom in school *s* as:

$$ITBS_{its}^{(fall)} = \beta_1 ADAPTIVE_s + \beta_2 EXP_{ts} + \beta_3 (ADAPTIVE_s \times EXP_{ts}) +$$

$$\beta_4 PRETEST + \sum \beta_k x_s + \epsilon_{its} \quad (4)$$

where *PRETEST* is a pre-randomization pretest covariate (student score on spring 2014 state reading test) included to improve precision, other variables are as defined earlier, and standard errors are clustered by school.

I also present models showing the main effect of Adaptive READS on student reading comprehension overall, and the main effect of Adaptive READS separately for the subgroups of students whose teachers were new to READS and those whose teachers had READS experience. Because the outcome is standardized to a mean 0 and sd of 1, the coefficients on *ADAPTIVE* in these models can be interpreted as effect sizes.

Results

Descriptive Statistics

In Table 1, I present descriptive statistics by condition for school- and teacher-level 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 in terms of years of experience and education. A slightly higher proportion of teachers in the Adaptive condition had prior experience with READS (.59 compared to .51, *n.s.*), and Adaptive READS teachers were slightly more likely to be black (.31 compared to .22, *n.s.*) or female (.95 compared to .87, *p*=.03) relative to Traditional READS teachers.

<Insert Table 1 about Here>

Teacher Outcomes

Literacy-related learning. In Table 2, I present models predicting teachers' standardized scores on the literacy learning index. In the first column, we see that condition did not have a significant main effect on teachers' self-reported learning (with a non-significant advantage for Adaptive READS of .13 *sd*), but teachers across conditions who were new to READS reported learning more than teachers who had participated in READS before (ES=.52 *sd*).

<Insert Table 2 about Here>

In the second column, I find that the effect of Adaptive READS differed significantly depending on whether teachers had past experience with READS. While the effect of Adaptive READS was negatively-signed and not significant for teachers new to READS, the effect of Adaptive READS was positive for teachers with past READS experience (ES=.43 *sd, p*=.07). These results are consistent with the theory behind the scaffolded model, as they show that the management structures were not equally effective for teachers with different levels of experience with the intervention. Specifically, the structures and activities of Adaptive READS were more beneficial for teachers who had previously participated in Traditional READS than were the structures and activities of Traditional READS.

I present this interaction graphically in Figure 4. The y-axis represents the original (unstandardized) teacher literacy learning index, with teachers' expected values reported on the original index scale for interpretive purposes. The x-axis contrasts teachers in the Traditional (Fidelity) condition to teachers in the Adaptive (Flexibility) condition. The red dashed line connects expected values for teachers with no prior READS experience, while the blue solid line connects expected values for teachers with prior READS experience. As can be seen, all subgroups of teachers have predicted values falling between 2 and 3, which represent "some" learning and "quite a bit" of learning, respectively. Examining the red dashed line, we see that among teachers with no READS experience, the Traditional condition promoted more learning (though not by a statistically significant amount). The blue solid line shows that among teachers with prior READS experience, the Adaptive condition promoted more learning (*p*=.07). Again, the difference-in-differences, which tests the scaffolded hypothesis, is statistically significant.

<Insert Figure 4 about Here>

In the third column of Table 3, I test whether Adaptive READS was more effective at promoting learning for teachers in schools in which a greater number of other teachers had experience with READS. The interaction was not statistically significant.

READS-related literacy activities outside of READS. In Table 3, I present models predicting the extent to which teachers incorporated READS-related principles and practices into their regular classroom instruction. As seen in column 1, the Adaptive condition had no significant main effect on this outcome (with a coefficient of .22 *sd*), and teachers' prior experience with READS also did not significantly predict their READS-related literacy practices outside of READS (-.23 *sd*).

<Insert Table 3 about Here>

However, in column 2, we again see that the effect of Adaptive READS differed significantly depending on whether the teacher had prior READS experience. The effect of condition was negatively signed and statistically zero for teachers new to READS, and was positive and marginally significant for teachers with READS experience (.56 *sd*, *p*=.06).

In Figure 5, I present this interaction graphically, again using model-predicted values on the original (unstandardized) survey scale. All groups' predicted values fall between 2 and 3 ("some" and "quite a bit" of use of the READS-related practices during regular classroom instruction). From the red dashed line, we see that among teachers with no prior READS experience, Traditional READS teachers used more READS practices (though the difference is not statistically significant). The blue solid line illustrates that, among teachers with READS experience, the Adaptive condition promoted more incorporation of READS practices into regular instruction (*p*=.06). Again, the difference-in-differences is statistically significant.

<Insert Figure 5 about Here>

In the third column of Table 3, I find that the effect of Adaptive READS on individuals' literacy practices did not differ depending on the number of a teacher's colleagues who had READS experience.

Student Reading Comprehension

In Table 4, I present models predicting student fall reading comprehension. As reported elsewhere (Kim et al., in preparation), Adaptive READS had a significant main effect on students' fall reading comprehension posttest, compared to Traditional READS (column 1). The results in columns 2-4 show that this main effect was driven by the subgroup of students whose teachers had READS experience.

In columns 2 and 3, I present the Adaptive main effects for the subgroups of students taught by teachers who were new to READS and those taught by teachers who had previous READS experience, respectively. The effect of Adaptive READS for students taught by inexperienced READS teachers was not significant (ES=-.03; column 2), while the effect size for students taught by teachers with READS experience was large and statistically significant (ES=.23). Furthermore, as indicated in column 4 through the interaction between Adaptive and teacher READS experience, the Adaptive effects were statistically different for students whose teachers did and did not have READS experience. These results are consistent with the hypothesis that the benefits of the flexibility condition for experienced teachers reported earlier translate into more effective instructional experiences for students.

<Insert Table 4 about Here>

Discussion

In this study, I compared a fidelity approach to educational program management to a flexibility approach in order to test the hypothesis that the fidelity approach would be better-suited for teachers new to the program while the flexibility approach would be better-suited for teachers who had previously experienced a fidelity version of the program. I found that fidelity management was better at promoting intervention-related learning and changes in practice for teachers new to the program, while flexibility management was better for teachers who had participated in (a fidelity version of) the intervention in the past. Finally, the Adaptive condition had a significant positive effect (compared to the Traditional counterfactual) on the reading comprehension of students taught by teachers experienced with Traditional READS, while having a statistically different, and null, effect for students taught by teachers new to READS. This result suggests that the positive effects on teacher outcomes of Adaptive READS among experienced READS teachers may have led to improved outcomes for students. As discussed below, the extent to which these results might generalize to other types of interventions is unclear; however, collectively our findings are consistent with the hypothesis that the optimal approach to educational program management is a scaffolded one, in which teachers first experience a period of fidelity-based management structures before collaboratively engaging in program adaptation.

From Binary to Continuous Constructs

Throughout this paper, I have used binary frameworks – “fidelity versus flexibility” for program management, and “experienced versus inexperienced” for teachers’ facility with a program. Applying simplifying heuristics is useful when developing and testing theory, but in practice, these concepts may exist as continua rather than as binaries (Berman, 1980). It is possible that the process of transitioning from fidelity to flexibility may be improved with intermediary scaffolds, such that implementers’ authority and decision-making increase gradually, perhaps beginning with simple decisions before building up to full flexibility. Some researchers have suggested that programs should include built-in adaptation suggestions (Webster-Stratton, Reinke, Herman, & Newcomer, 2011), which could serve as adaptation scaffolds. Similarly, suggestions for alternative learning experiences could be built into training materials so as to enable differentiated scaffolding when preparing teacher implementers (Harn, Parisi, & Stoolmiller, 2013). In short, the scaffolded sequence might be scaffolded differently across settings depending on local needs.

While I have focused on teachers’ experience with a particular set of instructional procedures, other dimensions of teacher experience or expertise are likely to be relevant to teachers’ success at implementing a program under each of the management approaches. Some teachers who are particularly skilled in general teaching practice may require less time in the fidelity phase, or may indeed be capable of bypassing that phase to immediately begin making program adaptations. Other teachers may need a much longer fidelity period in order to gain the skill necessary for effective adaptations. Relatedly, the effect of flexibility management on student outcomes may differ depending on teacher' overall level of effectiveness in addition to their experience with the particular intervention.

The Value of a Scaffolded Approach

Even in cases in which teachers are expected to implement a program with fidelity, program adaptation may be inevitable (Berman & McLaughlin, 1976; Datnow & Castellano, 2000). Consequently, it is important that teachers' adaptations do not compromise the effectiveness of the program. This requires that teachers have deep enough knowledge of the program theory to avoid detrimental adaptations. The scaffolded implementation sequence is a promising way to help teachers develop this knowledge, and the management of implementation experience could be designed with this pedagogical purpose in mind. Teachers' internalization of the program theory is likely to be improved if the fidelity phase is framed as an opportunity for teachers to learn the program before adapting it, as opposed to being framed as the end goal, where teachers' value comes primarily from the fact that they are executing the program designer's vision. In other words, given that teachers' instincts seem to be to adapt programs, the scaffolded approach can be a way of harnessing and focusing that instinct in a way that maximizes the potential for the adaptations to be productive.

Some scholars argue that implementers may be more likely to sustain programs over time when they adapt them to their context (Dearing, 2008). If a particular program has positive effects on student achievement, then sustainability is desirable. Consequently, program adaptation may serve the important goal of sustainability, even if the adaptations do not lead to measurable improvements in short-term intervention effects for students (compared to implementing the program with fidelity). Furthermore, there is potential for adaptation to lead to cascading effects. If teacher involvement in program decision-making leads to higher teacher morale and improved school culture, this may indirectly improve student outcomes (Lee, Dedrick, & Smith, 1991; Lee & Smith, 1996). Of course, adaptations that sustain a program while rendering it ineffective would be counterproductive. Again, this speaks to the value of providing scaffolds that prepare teachers for making effective adaptations.

Local Capacity and Will

Successful implementation of educational policies depends on both the capacity and the will of the implementers (McLaughlin, 1987). The scaffolded approach discussed here is primarily concerned with capacity. Although it is not easy for policymakers to influence local capacity, it may be easier than building will, given that training and consultation can be provided to improve capacity (McLaughlin, 1987). While more explicit research is needed on what, if any, effect the scaffolded approach may have on teachers' will to implement programs, theory suggests that positive feedback loops affecting teachers' will may arise. To begin with, will and capacity are related because teachers tend to be more willing to implement a program when they believe the program is effective (Kearns et al., 2010); building teachers' capacity to effectively implement a program may therefore also indirectly build their will to implement the program. Secondly, skillful teachers can be resentful of being asked to follow a program with fidelity, and involving teachers in the decision-making process is one way of earning teacher buy-in (Berman, 1980; Blakely et al., 1987). By framing the fidelity phase as a temporary scaffold that helps teachers acquire the knowledge and skill necessary for teacher-led adaptation, school leaders provide teachers with additional motivation for learning the program at a deeper level.

Limitations and Future Research

One way in which READS for Summer Learning differs from many other educational interventions is that it consists of both home- and school-based student learning experiences. While teachers play an important role in preparing students for successful program participation over the summer, the key learning experiences for students (i.e. reading the summer books) take place outside of teacher guidance or supervision. It is therefore unclear how the principles underlying the findings in this study might play out in a program that is entirely school-based or primarily teacher-led. On the one hand, we might expect some of the patterns seen in this study to be even more pronounced for interventions in which teachers play a more central role. For example, in a curricular intervention in which student learning relies entirely on teacher-led instruction, effects on student learning may be more sensitive to teachers' learning, instructional practice, and adaptations. On the other hand, adaptations to such a program may need to be more substantial in order for the adapted intervention to be sufficiently distinct from the intervention as originally designed. Relatedly, teachers may need more program-specific knowledge or general expertise in order to effectively adapt more complex programs. Finally, the demands made on teachers when collaboratively adapting a yearlong curricular intervention may be more taxing compared to what occurred in

READS. If teachers are opposed to more frequent collaborative meetings and a more demanding adaptation process, teacher investment in the program may be negatively impacted. Given all of these complexities, future research is needed in order to build an understanding of how fidelity versus flexibility management approaches play out with other types of educational interventions across various settings.

Another limitation is the self-report nature of the teacher outcomes. This concern is less about whether teachers' learning and behaviors were indeed affected in the ways suggested by these survey items; randomization reassures us about the causality of our inferences, and it seems unlikely that these interaction effects would be seen on teachers' perceptions of their learning and behaviors but not on their actual learning and behaviors. Additionally, the student learning results provide further support for the conclusion that teachers' actual learning and behaviors were affected. Instead, the limitation of the self-report outcomes is that we cannot know exactly how these measures of teachers' perceptions might relate to observable behavior change. The precise content of teachers' learning is unknown, and we cannot draw conclusions about whether certain teacher learning is relevant to changing practice and whether certain practices are relevant to improving student outcomes. In order to obtain a finer-grained picture of this process, further study will be needed.

Conclusion

Education researchers have the responsibility of producing knowledge that is useful to practitioners engaged in the complex process of school improvement.

While evaluation studies of educational programs or interventions may help us identify practices that work on average, educators want to know which practices fit best with their particular situation. By understanding the circumstances under which a fidelity approach versus a flexibility approach to educational program management will generally lead to improved outcomes, practitioners will be better-positioned to tailor school improvement efforts to their contexts. The findings in this study provide empirical support for the notion that fidelity and flexibility can form an effective scaffolded process of program implementation, and point toward new areas of exploration that can inform teacher-implemented instructional programs and educational programs more broadly.

Table 1.

Descriptive Statistics by Condition

	Control			Treatment				
	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	9.8	7.7	54	10.31	6.75	55	0.91	0.24
Number of years teaching in current grade level (grade 4)	4.44	4.92	55	4.04	4	54	-0.38	0.41
Number of years working at current school	4.64	5.68	55	4.73	5.4	55	0.15	0.80
Worked with READS before this school year? (1=Y, 0=N)	0.51		61	0.59		64	0.09	0.20
Have, or working toward, master's degree? (1=Y, 0=N)	0.53		55	0.55		55	0.02	0.69
Female (1=Y, 0=N)	0.87		61	0.95		64	0.09	0.03
Black (1=Y, 0=N)	0.22		55	0.31		55	0.10	0.28
White (1=Y, 0=N)	0.65		55	0.58		55	-0.08	0.34
Outcomes								
Literacy Learning Index (Std.)	-0.04	1.07	60	0.04	0.94	63	0.08	0.68
How much learn this sch yr about: matching books to students for indep. Reading	3.32	0.85	60	3.6	0.85	63	0.3	0.01
How much learn this sch yr about: teaching students a reading comprehension routine	3.62	0.94	60	3.6	0.85	63	0	0.99
How much learn this sch yr about: engaging students' families in student literacy	3.53	0.77	60	3.52	0.82	63	0	0.98
How much learn this sch yr about: supporting students' independent reading	3.67	0.91	60	3.6	0.82	62	-0.08	0.58
How much learn this sch yr about: increasing students' engagement in reading	3.65	0.84	60	3.71	0.83	63	0.07	0.65
READS-related Lit Practices Index (Std.)	-0.09	1.12	60	0.09	0.87	63	0.2	0.35
Over past 2 months, to what extent did you guide students' in selecting books for independent reading?	3.23	0.93	60	3.38	0.94	63	0.17	0.29
This school year, to what extent did you incorporate new strategies for teaching reading comprehension into your regular classroom practice?	3.45	0.98	60	3.67	0.8	63	0.2	0.23

Over past 2 months, how much emphasis did you place on engaging students' families in student literacy?	3.15	0.92	60	3.21	0.81	63	0.11	0.41
This school year, to what extent did you incorporate new strategies for supporting students' independent reading?	3.48	1.02	60	3.58	0.82	62	0.08	0.7
This school year, to what extent did you incorporate new strategies for engaging students in independent reading?	3.45	0.99	58	3.56	0.78	63	0.12	0.49

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).

Table 2.
Regression Models Predicting Teachers' Literacy-related Learning.

	(1) Literacy Learning Index (Std.)	(2) Literacy Learning Index (Std.)	(3) Literacy Learning Index (Std.)
Adaptive	0.128	-0.252	-0.373
	(0.192)	(0.231)	(0.471)
READS Experience	-0.520^{**}	-0.866^{***}	-0.546^{**}
	(0.143)	(0.162)	(0.159)
Adaptive*READS Experience		0.684^{*}	
		(0.264)	
Adaptive*Num. Other Exp. Teachers on Team			0.175
			(0.181)
Num. Other Exp. Teachers on Team			-0.182
			(0.122)
Num. Teachers on Team			0.229^{**}
			(0.0782)
N	123	123	123
R^2	0.232	0.258	0.269

Note. Cluster-robust standard errors in parentheses. All models control for fixed effects of randomization blocs.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.

Regression Models Predicting Teachers' use of READS-related Literacy Activities Outside of READS.

	(1) READS-related Lit Practices Index (Std.)	(2) READS-related Lit Practices Index (Std.)	(3) READS-related Lit Practices Index (Std.)
Adaptive	0.217	-0.209	-0.326
	(0.205)	(0.242)	(0.621)
READS Experience	-0.233	-0.621^{*}	-0.247
	(0.191)	(0.232)	(0.208)
Adaptive*READS Experience		0.767^{*}	
		(0.357)	
Adaptive*Num. Other Exp. Teachers on Team			0.251
			(0.248)
Num. Other Exp. Teachers on Team			-0.184
			(0.134)
Num. Teachers on Team			0.0672
			(0.157)
N	123	123	123
R^2	0.105	0.138	0.120

Note. Cluster-robust standard errors in parentheses. All models control for fixed effects of randomization blocs.

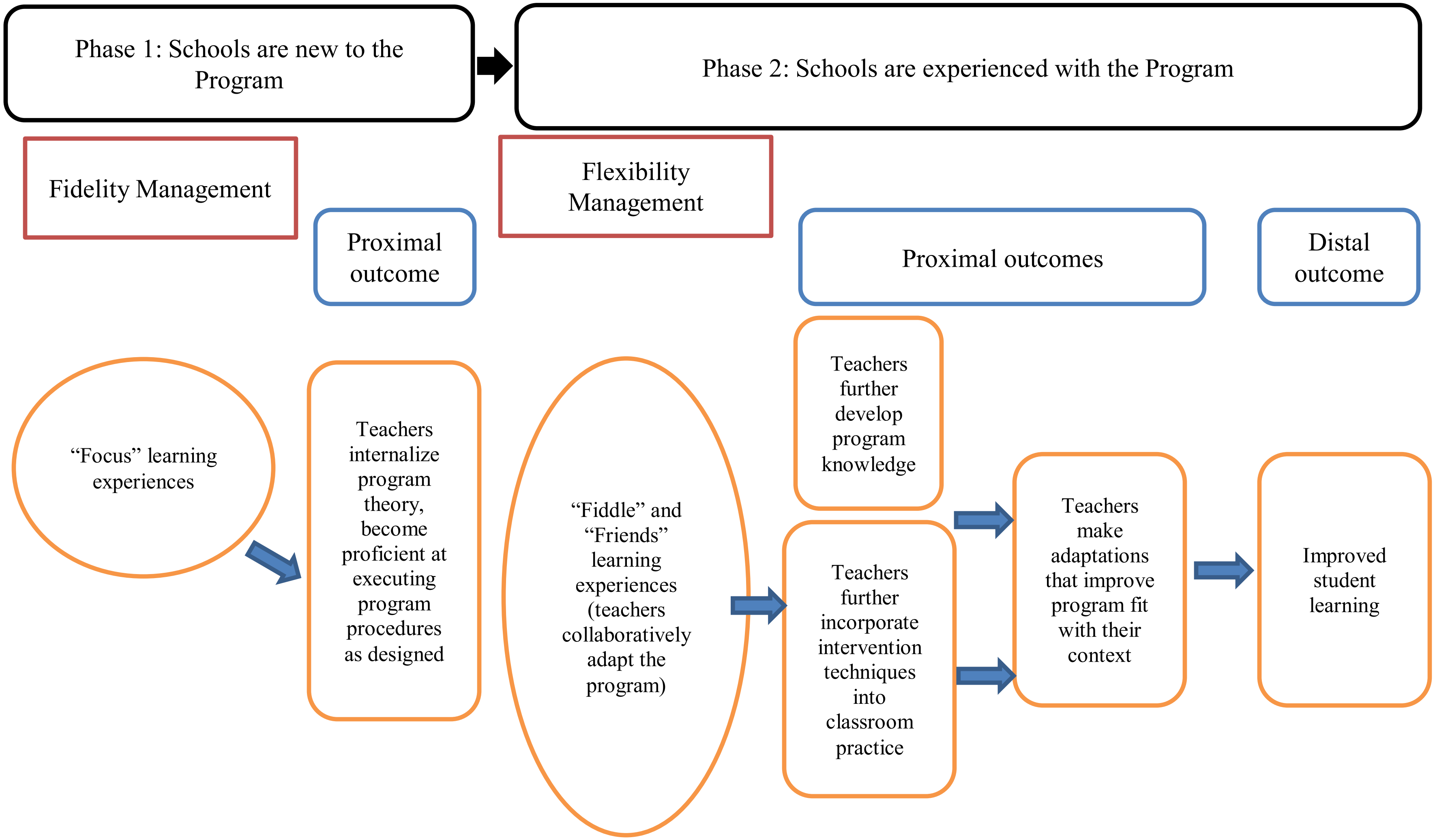
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.
Regression Models Predicting Student Reading Comprehension Posttest Scores.

	(1) All Teachers	(2) Teachers New to READS	(3) Teachers with READS Experience	(4) Interaction
Adaptive	0.118^{*}	-0.0324	0.226^{***}	-0.0128
	(0.0426)	(0.0614)	(0.0445)	(0.0607)
Teacher READS Experience	0.0375			-0.0993
	(0.0469)			(0.0632)
Adaptive*Teacher READS Exp.				0.249^{**}
				(0.0707)
N	1209	550	659	1209
R2	0.546	0.587	0.531	0.549

Note. Cluster-robust standard errors in parentheses. All models control for fixed effects of randomization blocs and student pretest.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 1. Conceptual Model for the Scaffolded Approach to Program Management


Phase 1: Schools are new to the Program
Phase 2: Schools are experienced with the Program
Fidelity Management
Proximal outcome
Flexibility Management
Proximal outcomes
Distal outcome
“Focus” learning experiences
Teachers internalize program theory, become proficient at executing program procedures as designed
“Fiddle” and “Friends” learning experiences (teachers collaboratively adapt the program)
Teachers further develop program knowledge
Teachers further incorporate intervention techniques into classroom practice
Teachers make adaptations that improve program fit with their context
Improved student learning

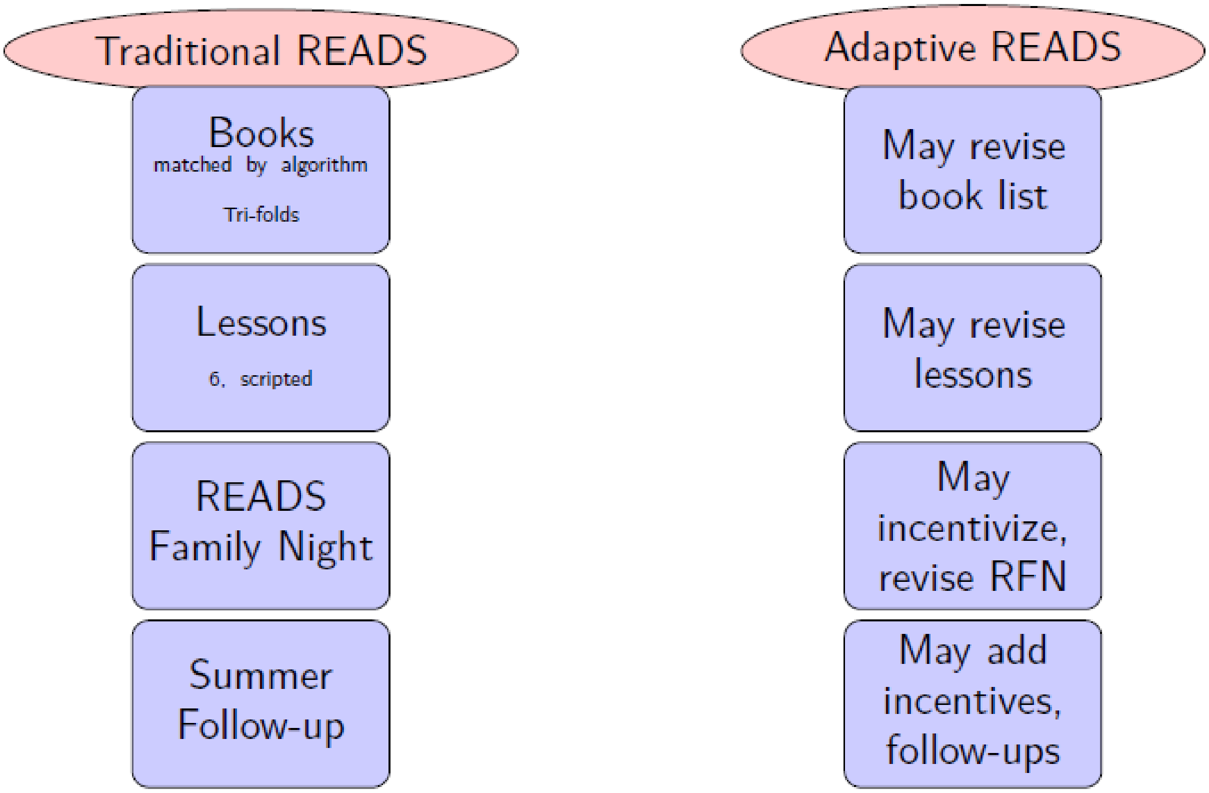

Traditional READS
Books
matched by algorithm
Tri-folds
Lessons
6, scripted
READS Family Night
Summer Follow-up
Adaptive READS
May revise book list
May revise lessons
May incentivize, revise RFN
May add incentives, follow-ups

Figure 2. Traditional and Adaptive READS.

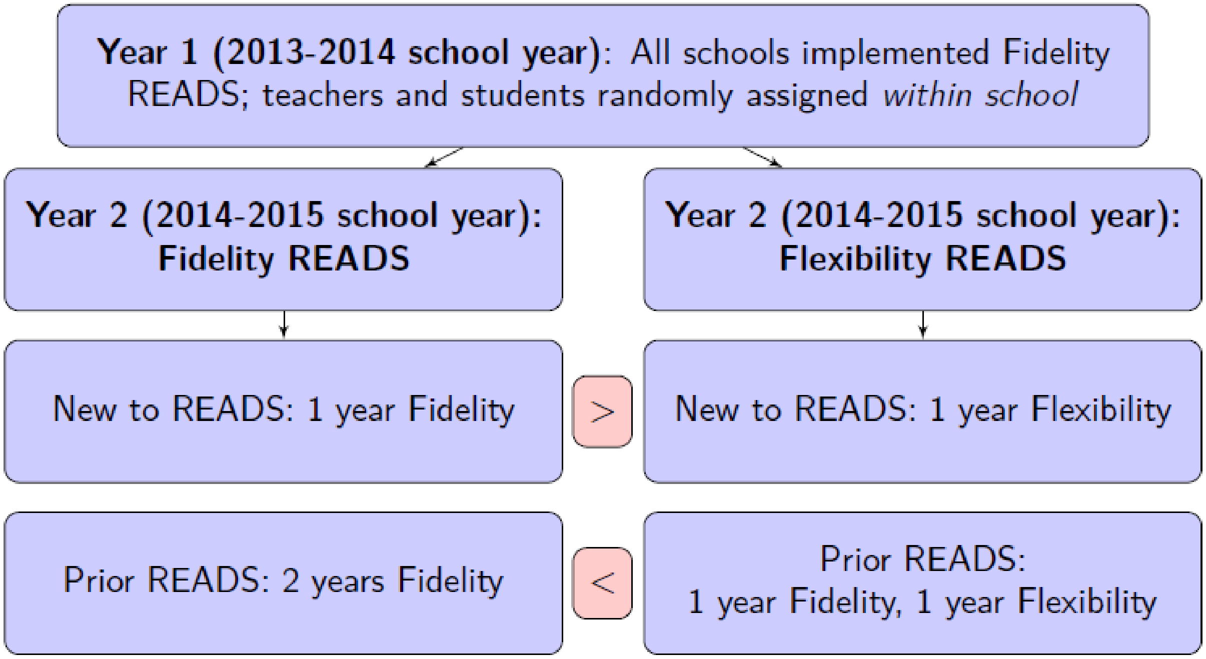

Year 1 (2013-2014 school year): All schools implemented Fidelity READS; teachers and students randomly assigned *within school*
Year 2 (2014-2015 school year): Fidelity READS
Year 2 (2014-2015 school year): Flexibility READS
New to READS: 1 year Fidelity
>
New to READS: 1 year Flexibility
Prior READS: 2 years Fidelity
<
Prior READS: 1 year Fidelity, 1 year Flexibility

Figure 3. Year 1 and Year 2 Randomization Schemes.

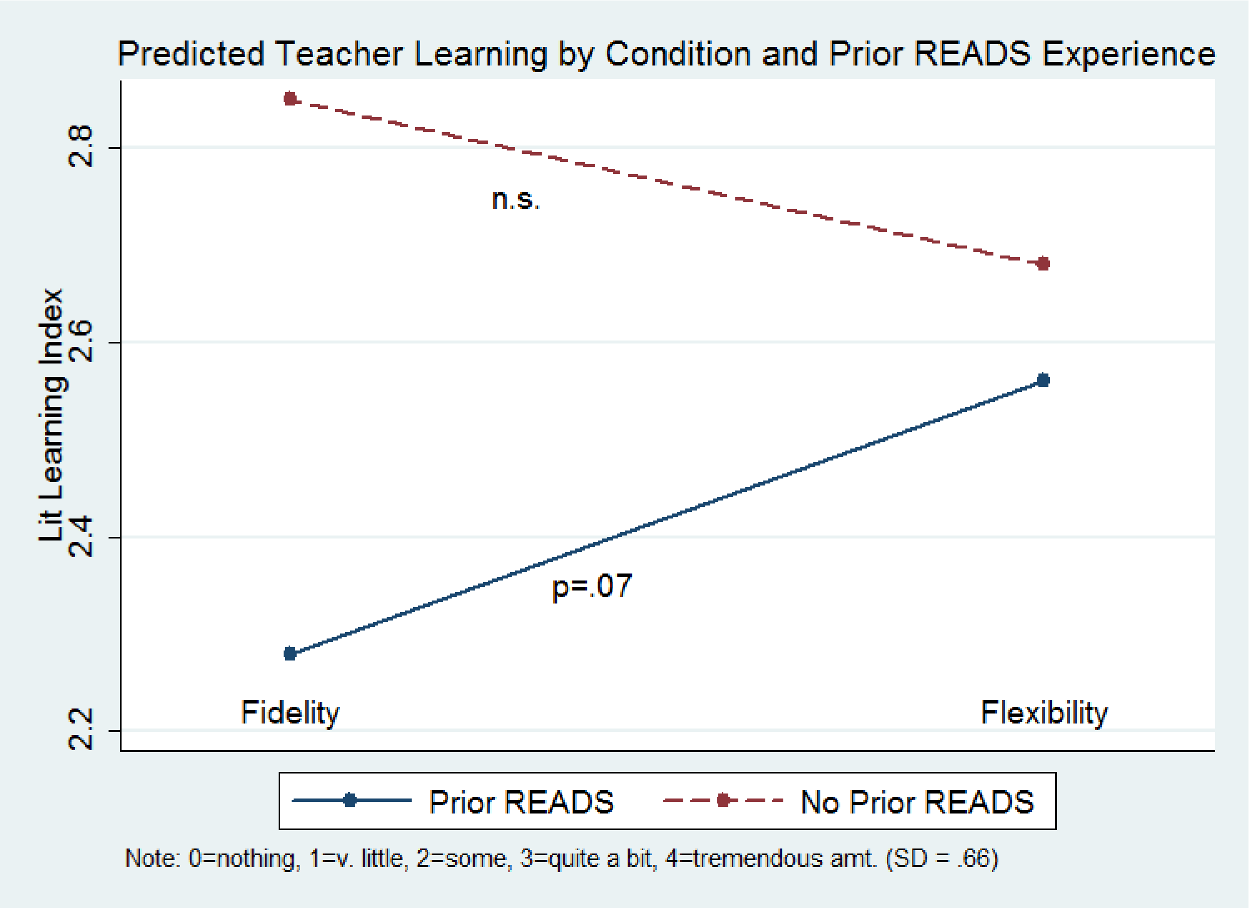


Figure 4. Interaction between treatment condition and teacher experience predicting intervention-related teacher learning. Difference in slopes is statistically significant at $p<.05$.

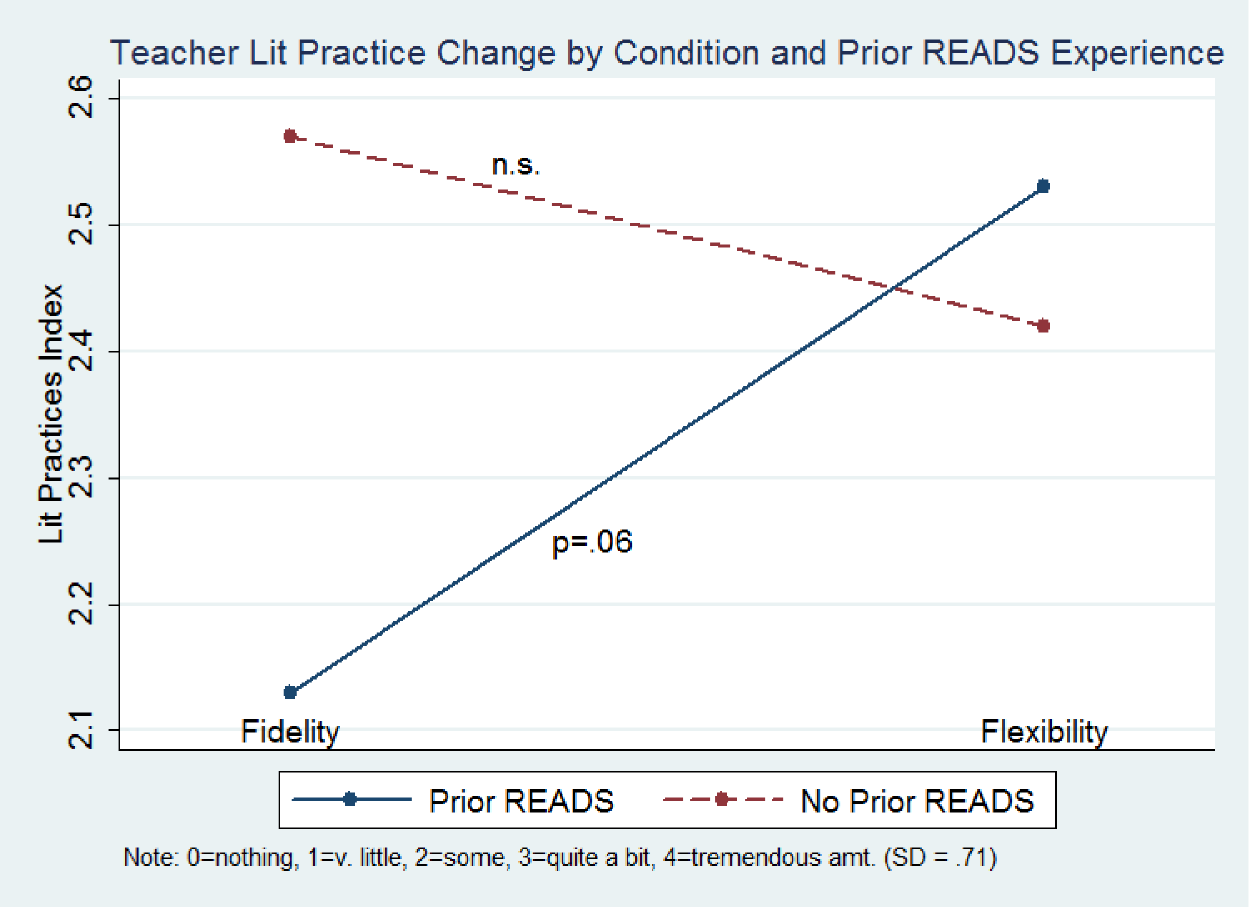


Figure 5. Interaction between treatment condition and teacher experience predicting teachers' changes in literacy practices. Difference in slopes is statistically significant at $p<.05$.

The Effects of Program Management Approach on Teachers' Professional Ties and Social Capital: Evidence from a Randomized Trial

In a growing body of literature, education researchers are applying social network theory to study teacher learning and school improvement (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. 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 a variety of 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 innovation 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 malleable organizational and management factors that shape tie formation and social capital exchange within schools. Such research could help school and district leaders predict the ways in which various interventions and organizational restructuring efforts might affect professional networks, and enable administrators to encourage tie-formation for the purpose of leveraging 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. Furthermore, theory suggests opposing hypotheses on how introducing an educational intervention into a school may affect teachers' social capital in instructional areas outside of the intervention, and empirical evidence on this question is also lacking.

In this study, I take a decision-making perspective on tie formation (Nebus, 2006) to understand how contrasting approaches to organizing teachers' roles in an educational intervention affect participants' network outcomes. Using data from a cluster-randomized trial of READS, a summer literacy program for 4th graders that includes school-based and home-based elements, I offer the first experimental evidence on the formation of teachers' professional ties. Specifically, I compare two versions of the program: Traditional READS, in which teachers are expected to implement researcher-designed program procedures with fidelity, and Adaptive READS, in which teachers work collaboratively to adapt the program in ways they believe will make it more effective in their schools. I go beyond past research to examine how teachers' consultation ties, and the content of their consultations, are causally impacted by the way their work tasks are organized, and how these effects differ depending on the individual's position in the organizational structure.

I begin by providing background on network theory and the relevance of teacher ties to school improvement. I then summarize the decision-making perspective theory on how ties are formed, outline different approaches to instructional management, and discuss implications of tie-formation theory for how different approaches to instructional management may differentially affect tie formation in schools. Next, I describe Adaptive and Traditional READS, the two contrasting models of intervention management studied here. Finally, I describe the methods, present results, and discuss implications.

Background

Network Theory, Social Ties, and Social Capital

Researchers have increasingly applied social network theory, and the concept of social capital, to the study of teacher learning and school improvement (Spillane et al., 2014). 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, pp. 100-101, emphasis in original). Social capital "facilitate[s] productive activity" (Coleman, 1988, p.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, the productive aspects of social ties that education researchers have focused on include the capability of ties to transmit advice and information, diffuse innovation, support the implementation of reform initiatives, and serve as a source of moral support for teachers.

Social ties and school improvement.

Information-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 advice and 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.

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 et al., 2004).

Reform efforts. The ties held among teachers within a school also 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, norms 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.

Tie Formation

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 us to predict how various interventions and organizational restructuring efforts may affect professional networks, and will enable school leaders to leverage ties and social capital in support of school-wide instructional improvement.

Following Nebus (2006), I adopt a decision-making perspective on how information and advice ties 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. According to the decision-making perspective, such predictors are simply additional factors that individuals consider when weighing the value and costs of pursuing a tie. For example, teachers seeking instructional advice are more likely to expect that teachers in their same grade level will have useful advice (compared to teachers outside their grade level); 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 under contrasting management approaches. The decision-making perspective on tie-formation is helpful when considering how different approaches to instructional reform and management may affect the networks and social capital in schools. Two common and contrasting management approaches to instructional improvement are what have been called the “fidelity” and “flexibility” 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 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 flexibility 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).

Theory suggests that fidelity and flexibility approaches to educational interventions will have different effects on 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 approach presents teachers with a series of tasks to implement, the flexibility 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 flexibility approach may introduce more of a perceived value to contacting alters, resulting in more tie-generation and social capital exchange compared to the fidelity approach.

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). The responsibilities held by people in different positions of an organizational structure vary, and therefore the types of second-level goals they seek to achieve differ. The decision-making perspective suggests that this will motivate egos to seek different types of expertise from different alters. 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, within a group of people who are all working on the same project, different people 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 (Coburn et al., 2013; Atteberry & Bryk, 2010). Furthermore, the establishment of formal structures for teacher interaction has been associated with 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, it remains unclear 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 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.

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 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 offers contrasting predictions about how an intervention 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.

In this study, I contribute to the literature on teacher networks by presenting unique causal evidence on these issues; in particular, I examine the effects of implementing a particular intervention through a flexibility management approach, as compared to a fidelity management approach. Using data from a school-level cluster-randomized trial of Adaptive READS, a collaborative, teacher-adapted summer reading program for fourth graders, I ask:

What are the effects of an educational intervention employing a flexibility approach to management, as compared to an intervention employing a fidelity approach to management, on:

1) participants' number of intervention-related ties overall, and on teachers' ties with alters in specific intervention roles? (and do these effects differ by the participant's role in the intervention?)

2) the frequency with which participants consult with alters for different intervention-related purposes? (and do these effects differ by the participant's role in the intervention?)

3) participants' number of intervention-*unrelated* ties overall, and the presence of ties with participants in specific intervention roles? (and do these effects differ by the participant's role in the intervention?)

4) the frequency with which participants access social capital for different intervention-*unrelated* purposes? (and do these effects differ by the participant'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. I compare two versions of READS, which were randomly assigned to be executed at different schools over the 2014-2015 school year and summer of 2015: Traditional READS and Adaptive READS. In both versions, only fourth grade students, their teachers, and school coordinators (described below) participated. Traditional READS is an evidence-based program (Kim, Guryan, White, Quinn, Capotosto, & Kingston, 2016) representing a fidelity approach in which teachers receive training and resources to support their adherence to researcher-designed program procedures. In contrast, Adaptive READS takes a flexibility approach by having teachers work collaboratively with their grade-level teams to adapt READS in ways they believe will increase the program's effectiveness.

Traditional READS. Students in Traditional 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).

Traditional 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 the summer activities. 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, parents 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 Traditional 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 during which they learned the underlying research-based principles of READS. Teachers received school-specific data from a previous year of (Traditional) READS implementation (e.g. data on tri-fold return rates and RFN attendance) and examined these data with their grade-level teams 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 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, 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 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 (Traditional and Adaptive). The role of the CIS READS Lead differed slightly for each condition. For Traditional 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 Traditional 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 Traditional READS, teachers received $300 and SCs received $600.

As discussed above, 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 approach versus a flexibility approach on SCs' network outcomes may differ from the effect on teachers' network outcomes. In addition, it will 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 Traditional READS for at least one year prior. These schools were recruited because familiarity with the READS procedures would better enable Adaptive READS schools to make productive program adaptations. Although each participating school had prior involvement with Traditional 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 pair (or triad), one randomly-selected school was assigned to Adaptive READS; the other schools were assigned to Traditional READS. All fourth grade teachers at each participating school were required to implement their school's version of READS.

Measures

Teachers and school coordinators completed a web-based survey in the spring with questions about their intervention experiences (including constructs not examined here). 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.

Network ties (intervention-related and intervention-unrelated). I 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 my interest was in the effects of the management structure on participating teachers' ties, I took an egocentric approach to network analysis. First, we surveyed teachers about their general ego networks for 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 2 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, though 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 for this consultation.

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 above suggests that alters outside of an ego's primary network are particularly important for exposing egos to novel information, perspectives, or advice. As such, I 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, I 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. I created an analogous set of outcome variables related to consultation on instruction in general, unrelated to READS.

Frequency of consultation for various content. The flexibility approach to organizing READS is hypothesized to affect not only to the presence or absence of particular ties for participants, but also the content of participants' consultations with their colleagues. For intervention-related consultation, I 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." These choices were given values of 1-5 and standardized to a mean of 0 a standard deviation of 1 before analyzing.

For intervention-unrelated consultation, I 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 NC EOG test, and classroom management. Answer choices for these questions were the same 5 frequency categories listed above. I 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. I used these predicted component scores, standardized to a mean of 0 and *sd* of 1, as the "non-READS consult index."

Analytic Plan

For each of the outcomes described above, I fit models of the form:

$$Y_{is} = \beta_0 + \beta_1 ADAPTIVE_s + \beta_2 SC_i + \beta_3 NETSIZE_s + \pi RB_s + \epsilon_{is} \qquad (1)$$

where *i* indexes teacher (or SC), *s* indexes school, 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 (as compared to the Traditional READS condition), *SC* is an indicator for whether the respondent is the school coordinator, *NETSIZE* is the number of people on the school's READS team, and *RB* is a vector of indicator variables representing randomization blocs. In all models, I use school-level cluster-robust standard errors (with proper adjustments for finite group-level sample size). To test whether the effect of Adaptive READS differed for teachers and SCs, I fit additional models that add to model 1 an interaction between *SC* and *ADAPTIVE.*

In addition to fitting models of the form presented above, I conducted numerous sensitivity analyses with alternative modeling strategies, depending on the outcome. Sensitivity analyses revealed that results were not sensitive to modeling strategy, so for consistency and interpretability, I present results based on a version of model 1 for all outcomes (see Appendix B for results from alternative modeling specifications). However, the statistical significance of some results was sensitive to the use of clustered versus classical standard error or random effects for schools.

Results

Descriptive Statistics

In Table 1, I 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 in terms of years of experience and education. A slightly higher proportion of teachers in the Adaptive condition had prior experience with READS (.59 compared to .51, *n.s.*), and Adaptive READS teachers were slightly more likely to be female (.95 compared to .87) or black (.31 compared to .22, *n.s.*) compared to Traditional READS teachers. Importantly, the size of the READS teams tended to be slightly larger in the Adaptive schools (5.4 members on average, compared to 4.5 in Traditional 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).

<Insert Table 1 about Here>

Effects on Intervention-Related Ties and Consultation

In Table 2, I present models predicting intervention-related ties. In column 1, I test whether Adaptive READS affected teachers' total number of intervention-related ties; this column incudes ties that teachers reported with other teachers in their 4th grade team, school coordinator, CIS Lead, and other educators at their school outside of their 4th grade team. As seen, Adaptive READS caused teachers to expand their intervention networks, with Adaptive READS teachers reporting having consulted with approximately .5 more people about READS, compared to Traditional READS teachers in schools with similarly-sized READS teams.

Also evident from column 1 is that overall, school coordinators consulted with 1.8 more people about READS, on average, than did 4th grade teachers. In column 2, I test whether the effect of Adaptive READS on participants' READS ties differed depending on whether the participant was a school coordinator. Here, we see a significant and negatively-signed interaction between Adaptive and School Coordinator. Correspondingly, we also see that the effect for teachers was larger than the overall effect (nearly equal to adding one alter to the ego's READS network). A post-hoc test revealed that the effect of Adaptive READS was not significant for SCs (b=-.73, p=.22).

<Insert Table 2 about Here>

I next examine whether Adaptive READS made participants more likely to consult with alters in particular organizational positions. In column 3, a linear probability model reveals that Adaptive READS increased the proportion of participants who consulted with their school's CIS READS Lead by approximately .16, compared to Traditional READS. Proportionally, more SCs consulted with CIS Leads than did teachers, though column 4 reveals that we cannot reject the null hypothesis of equal effects of Adaptive for teachers and SCs (note, however, that the point estimate for SCs is negatively signed).

Column 5 uses data from only non-SC participants to test whether Adaptive READS made teachers more likely to consult with their school coordinator about READS. The point estimate on Adaptive is a marginally significant .19 (*p*=.095, 95% CI=-.03, .41).

In columns 6 and 7, I continue investigating whether Adaptive READS made teachers more likely to consult with alters in particular roles. We see that Adaptive READS participants did not consult with a greater number of alters from their READS teams compared with Traditional READS participants, and this effect did not differ depending on whether the participant was a teacher or a SC. In both conditions, participants typically consulted with most of the other members of their school's READS team, leaving little room for an effect on number of ties within the READS team. As seen in column 8, Adaptive READS had an overall marginally significant positive effect on the number of alters that participants consulted with from outside the school's READS team (b=.28, *p*=.09, 95% CI: -.05, .61). For the subgroup of participants who were teachers, the effect of Adaptive READS was larger and statistically significant; the effect for SCs was negatively-signed, though we cannot reject the null hypothesis of no treatment effect or of different treatment effects for teachers and SCs (column 9).

In Table 3, I examine treatment effects on the content of teachers' consultations. We would expect that the content of Traditional READS participants' consultations would focus more on implementation while Adaptive READS participants' consultations would focus more on adaptations. Column 1 of Table 3 shows a negative, marginally significant effect of Adaptive READS on the frequency with which participants consulted with colleagues about implementing READS as designed by the researchers (ES=-.41 *sd*). Column 2 reveals significant treatment effect variation for teachers versus SCs, with the effect size for teachers being a significant -.69 *sd*, and the effect for SCs being significantly different and positively signed, at .63 *sd* (1.329-.691; *p*=.07).

<Insert Table 3 about Here>

As seen in column 3, the overall effect of Adaptive READS on the frequency with which participants consulted with colleagues about adaptations to READS was a significant .52 *sd.* However, as seen in column 4, this effect was largely driven by SCs; while the effect for teachers was not statistically different from 0 (ES=.32 *sd*), the effect was significantly different for SCs, at 1.23 *sd.* 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.

Summary of effects on intervention-related outcomes. To summarize, organizing READS as a flexibility versus fidelity intervention mattered for the size of participants' intervention-related networks, the roles of the alters with whom participants consulted, and the frequency of participants' consultations on different content. The adaptive, collaborative version of the program caused participants to have more intervention-related ties, and this effect was driven by teacher participants (as opposed to SCs). This was because the program made participants more likely to consult with their CIS Lead and with people from outside of their school's READS team. The adaptive version of the intervention did not make teachers more likely to consult with members of their school's READS team about the intervention, but in both conditions, participants typically consulted with most of the other members of their school's READS team, leaving little room for an effect on number of ties within the READS team. The adaptive version of READS also decreased the frequency with which teachers consulted with colleagues about implementing READS as designed by researchers, and curiously, may have increased the frequency with which SCs consulted with colleagues about implementing READS as designed by researchers. The adaptive version of the program increased the frequency with which participants consulted with colleagues about making adaptations to READS, though this effect was driven primarily by SCs as opposed to teachers.

Effects on Non-intervention-related Ties and Consultation

In Table 4, I present the results of models testing the effect of the adaptive approach to READS on participants' ties in instructional areas unrelated to the intervention. In columns 1 and 2, the outcome is the total number of participants' ties related to instructional areas other than READS. As seen here, the adaptive approach to READS appears to have decreased participants' number of non-READS consultation ties by approximately one person, compared to teachers under a control-based management approach (*p*=.06, 95% CI: -2.13, .05). However, the marginal significance of this estimate is sensitive to the method used for accounting for error correlation; the estimate is not significant when classical (as opposed to clustered) standard errors are used, or when random effects for schools are used. This negative effect did not differ for teachers and SCs (column 2).

<Insert Table 4 about Here>

This overall negative effect masks interesting differences in effects on different types of ties. Adaptive READS in fact increased participants' probability of consulting with their school's CIS READS Lead on a non-READS instructional matter, by approximately .13 (column 3), and this effect did not differ significantly for teachers and SCs (column 4). Adaptive READS had no effect on teachers' probability of consulting with their SC on a non-intervention instructional area (column 5).

Columns 6-9 reveal the source of the overall negative effect on non-intervention ties. As seen in column 6, the adaptive, collaborative work arrangement caused participants to consult with fewer members of their school's READS team about instructional matters unrelated to the intervention, compared to Traditional READS participants in READS teams of the same size (with Adaptive READS participants reporting .3 fewer ties, on average). This negative effect did not differ for teachers and SCs (column 7). Similarly, column 8 suggests that the adaptive version caused participants to consult with .86 fewer educators at their school who were not members of the READS team, on average (*p*=.07, 95% CI: -1.79, .06), and this effect did not differ for teachers and SCs (column 9).

In Table 5, I examine the effect of the adaptive, collaborative intervention on the frequency with which participants consulted with their colleagues about non-intervention instructional matters. Again, the outcome here was a standardized (mean 0, *sd* 1) PCA-derived index comprised of questions about the frequency of participants' consultation with colleagues on a variety of instructional matters unrelated to READS.

<Insert Table 5 about Here>

In column 1, we see that overall, Adaptive READS had a marginally significant negative effect of .33 *sd* on the frequency with which participants consulted with colleagues on non-READS instructional matters (*p*=.07, 95% CI: -.69, .02). As evidenced in column 2, this negative effect was driven by teachers (as opposed to SCs). The positively signed, significant interaction between the *ADAPTIVE* and the *SC* indicators imply that the work arrangement did not significantly affect SCs' non-intervention consultation frequency (b=.388, *p*=.362). For teachers, however, the effect was a statistically significant -.529 *sd.*

Summary of effects on intervention-unrelated outcomes. To summarize, the effects of Adaptive READS on non-intervention network outcomes were nuanced, with variation observed depending on the role of the alter or the role of the ego. Overall, the adaptive, collaborative work arrangement may have decreased the number of non-intervention ties held by participants, yet Adaptive READS increased the probability that a participant would consult with his or her CIS READS Lead on a non-intervention instructional matter while decreasing the number of intervention-unrelated ties held with alters from the ego's school READS team. Additionally, there is evidence that the program decreased the number of non-interventions ties between participants and their colleagues outside of the READS team. Adaptive READS also had a significant negative effect on the frequency with which teachers consulted with colleagues about non-intervention matters, while having a significantly different, and null (but positively signed) effect for SCs.

Discussion

This study offers the first causal evidence on how the organization of the work of an educational intervention can affect educators' social capital in the short term, as measured by consultation ties and frequency of different types of consultation. I find that the fidelity and flexibility approaches to managing an educational intervention differentially affect teachers' social capital not only in relation to the intervention, but in instructional areas unrelated to the intervention. Furthermore, the organizational positions of participants influence whether they will seek consultation and whether they will be sought for consultation. When adopting specific interventions, then, schools should consider how the instructional management approach of the intervention, and educators' roles in the intervention, will affect not only the intervention-related social capital at the school, but also the social capital around non-intervention areas. For example, administrators should consider whether building teachers' social capital around some particular intervention or school improvement effort is worth the potential trade-off of the dissolution of social capital in other instructional areas outside of the intervention.

Intervention-related Outcomes

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 more 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 to consult with their grade-level team about READS (compared to Traditional READS teachers), 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 network-formation theory, 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 that teachers' roles in the intervention induced more perceived value at level 2 in contacting alters for consultation.

The simultaneous null effect on egos' ties with READS team alters and positive effect on egos' ties with colleagues outside of the READS team can also be interpreted in light of network-formation theory. 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, 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 Traditional 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.

Given the differing second-level outcomes across conditions, it is also not surprising that Traditional 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 marginally significantly different from zero) effect of .64 *sd*? 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).

Intervention-unrelated Outcomes

Theory on tie formation also helps make sense of the observed effects on non-intervention instructional ties and consultation. As Adaptive READS increases the perceived value of contacting alters for READS-related consultation, the flip side is that the perceived cost of contacting alters for consultation unrelated to READS increases. Theoretically, 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 on which they can consult with some fixed number of alters over a given period of time.

If network ties and consultation are zero-sum matters, this has important implications for schools' decisions to adopt particular interventions or professional development experiences. Careful thought should therefore be given to the endeavors around which schools decide to build social capital to ensure that social capital is built around supporting the activities that will yield the most benefit to students.

Limitations and Future Research

One limitation of this study, which suggests a fruitful area of future research, is that the effects observed were short-term, demonstrating how networks differ across management approaches in the concluding months of an intervention. Whether these changes are temporary or more permanent is unknown. Theory suggests that networks are dynamic (de Lima, 2010b) and that ties dissolve after some period of disuse (Nebus, 2006). This suggests that the long-term effects of an instructional management approach might depend on how long the school maintains that approach. In the current study, for example, the observed reduction in teachers' intervention-unrelated ties in the Adaptive group may be maintained if the schools remain focused on the activities of Adaptive READS. Similarly, the ties that participants formed with their schools' CIS READS Lead could dissolve after the discontinuation of the intervention.

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, I 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 observed decrease in intervention-unrelated consultation 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. The contribution of this study, then, lies in its illumination of the effects on the channels through which social capital flows – to whom, from whom, and under what management approaches. 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.

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

Network theory has illuminated the important role that social capital can play in school improvement efforts. This study presents some of the first causal evidence on 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 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, 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 effects on these first-level network outcomes enable schools to better accomplish their second-level outcomes of improving student learning outcomes.

Table 1. Descriptive Statistics by Condition

	Traditional (control)			Adaptive (treatment)				
	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	9.8	7.7	54	10.31	6.75	55	0.91	0.24
Number of years teaching in current grade level (grade 4)	4.44	4.92	55	4.04	4	54	-0.38	0.41
Number of years working at current school	4.64	5.68	55	4.73	5.4	55	0.15	0.80
Worked with READS before this school year? (1=Y, 0=N)	0.51	0.5	61	0.59	0.5	64	0.09	0.20
Have, or working toward, master's degree? (1=Y, 0=N)	0.53	0.5	55	0.55	0.5	55	0.02	0.69
Female (1=Y, 0=N)	0.87	0.34	61	0.95	0.21	64	0.09	0.03
Black (1=Y, 0=N)	0.22	0.42	55	0.31	0.47	55	0.1	0.28
White (1=Y, 0=N)	0.65	0.48	55	0.58	0.5	55	-0.08	0.34
Number on School READS Team (teachers & school coordinator)	4.51	0.81	61	5.41	1.42	64	0.84	0.03
Outcomes								
Number READS alters	4.07	1.8	60	5.11	1.98	63	1.04	0
Consulted CIS READS Lead about READS (1=Y, 0=N)	0.23	0.43	60	0.35	0.48	63	0.13	0.01
Consulted READS School Coordinator about READS (1=Y, 0=N)	0.65	0.48	46	0.75	0.44	52	0.14	0.12
Number READS alters from school READS team (teachers & SC only)	3.02	0.91	60	3.73	1.32	63	0.68	0.02
Number READS alters outside school READS team & CIS Lead	0.82	1.38	60	1.03	1.11	63	0.23	0.15
Frequency consult with colleagues about implementing READS (std)	0.24	0.99	60	-0.23	0.96	63	-0.42	0.04
Frequency consult with colleagues about adapting READS (std)	-0.25	1.1	60	0.24	0.83	63	0.55	0.01
Number non-READS alters	8.43	4.38	60	8.35	4.87	63	0.02	0.98
Consulted CIS READS Lead on non-READS instructional area (1=Y, 0=N)	0.13	0.34	60	0.22	0.42	63	0.1	0.04
Consulted READS School Coordinator on non-READS instructional area (1=Y, 0=N)	0.5	0.51	46	0.44	0.5	52	-0.02	0.81
Number non-READS alters from school READS team (teachers & SC only)	2.88	0.98	60	3.17	1.21	63	0.28	0.32
Number non-READS alters outside school READS team & CIS Lead	5.42	4.09	60	4.95	4.22	63	-0.36	0.59
Index for frequency of consultation with colleagues on non-READS instructional areas (std)	0.12	0.96	60	-0.12	1.03	63	-0.2	0.28

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. Treatment Effects on READS Consultation Ties

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Num. READS Alters (Total)	Num. READS Alters (Total)	Consult CIS Lead on READS	Consult CIS Lead on READS	Consult SC on READS	Num. READS Alters from READS Team	Num. READS Alters from READS Team	Num. Non-READS Team READS Alters	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	0.529**	0.875***	0.158**	0.210*	0.188$^{\sim}$	0.088	0.158	0.282$^{\sim}$	0.506*
	(0.145)	(0.226)	(0.047)	(0.085)	(0.108)	(0.069)	(0.124)	(0.160)	(0.197)
SC	1.804***	2.528***	0.243$^{\sim}$	0.352$^{\sim}$		0.406$^{\sim}$	0.552**	1.156***	1.624**
	(0.392)	(0.409)	(0.141)	(0.187)		(0.204)	(0.185)	(0.302)	(0.465)
Net. Size, Spr.	0.731***	0.711***	-0.015	-0.018	-0.056	0.728***	0.724***	0.018	0.005
	(0.069)	(0.071)	(0.028)	(0.029)	(0.043)	(0.028)	(0.029)	(0.057)	(0.058)
Adaptive*SC		-1.606*		-0.242			-0.325		-1.040$^{\sim}$
		(0.739)		(0.287)			(0.428)		(0.549)
Constant	0.339	0.256	0.237	0.224	0.886***	-0.357*	-0.373*	0.459	0.405
	(0.355)	(0.320)	(0.143)	(0.141)	(0.185)	(0.166)	(0.162)	(0.303)	(0.289)
N	123	123	123	123	98	123	123	123	123
R^2	0.424	0.451	0.119	0.130	0.403	0.624	0.627	0.232	0.259

Note. SC=school coordinator; net size spr = number of possible alters in teacher's network in the spring. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Model 5 does not include SCs.

Table 3. Treatment Effects on Frequency of READS Consultation on Implementation and Adaptation

	(1) Consult on READS Implementation (Std.) b/se	(2) Consult on READS Implementation (Std.) b/se	(3) Consult on READS Adaptations (Std.) b/se	(4) Consult on READS Adaptations (Std.) b/se
Adaptive	-0.405$^{\sim}$	-0.691**	0.518*	0.323
	(0.207)	(0.220)	(0.236)	(0.248)
Sch. Coordinator	0.297	-0.302	0.183	-0.223
	(0.219)	(0.217)	(0.204)	(0.236)
Network Size (Spr.)	0.002	0.019	0.047	0.058
	(0.105)	(0.106)	(0.115)	(0.116)
Adaptive*SC		1.329***		0.903*
		(0.350)		(0.351)
Constant	0.136	0.205	-0.534	-0.488
	(0.520)	(0.519)	(0.584)	(0.592)
N	123	123	123	123
R^2	0.166	0.236	0.181	0.214

Note. SC=school coordinator. Network size spr= number of possible alters in teacher's network in the spring. 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.

Table 4. Treatment Effects on Instructional (non-READS) Consultation Ties

	(1) Num. Non-READS Alters (Total) b/se	(2) Num. Non-READS Alters (Total) b/se	(3) Consult CIS Lead on Non-READS b/se	(4) Consult CIS Lead on Non-READS b/se	(5) Consult SC on Non-READS b/se	(6) Num. Non-READS Alters from READS Team b/se	(7) Num. Non-READS Alters from READS Team b/se	(8) Num. Non-READS Alters outside READS Team b/se	(9) Num. Non-READS Alters outside READS Team b/se
Adaptive	-1.042$^{\sim}$	-1.102$^{\sim}$	0.128**	0.105$^{\sim}$	-0.021	-0.306*	-0.376*	-0.864$^{\sim}$	-0.831
	(0.531)	(0.587)	(0.038)	(0.052)	(0.096)	(0.132)	(0.142)	(0.451)	(0.570)
SC	5.536***	5.410**	0.337**	0.289$^{\sim}$		-0.052	-0.199	5.251***	5.320**
	(1.291)	(1.494)	(0.115)	(0.142)		(0.286)	(0.422)	(1.187)	(1.447)
Net Size (Spr.)	1.642**	1.645**	-0.014	-0.013	0.002	0.695***	0.699***	0.961$^{\sim}$	0.960$^{\sim}$
	(0.524)	(0.534)	(0.025)	(0.026)	(0.038)	(0.048)	(0.046)	(0.492)	(0.501)
Adaptive*SC		0.281		0.107			0.327		-0.153
		(2.629)		(0.241)			(0.550)		(2.392)
Constant	-0.344	-0.330	0.116	0.122	0.468*	-0.246	-0.229	-0.214	-0.222
	(2.651)	(2.632)	(0.129)	(0.128)	(0.172)	(0.210)	(0.223)	(2.542)	(2.533)
N	123	123	123	123	98	123	123	123	123
R^2	0.412	0.412	0.241	0.244	0.613	0.476	0.479	0.387	0.387

Note. SC=school coordinator; net size spr = number of possible alters in teacher's network in the spring. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Model 5 does not include SCs.

Table 5. Treatment Effects on Frequency of Instructional (non-READS) Consultation.

	(1) Non-READS Consult Index (Std.) b/se	(2) Non-READS Consult Index (Std.) b/se
Adaptive	-0.332$^{\sim}$	-0.529**
	(0.173)	(0.175)
Sch. Coordinator	-0.204	-0.617*
	(0.224)	(0.255)
Network Size (Spr.)	0.139*	0.150*
	(0.059)	(0.059)
Adaptive*Sch. Coordinator		0.917*
		(0.441)
Constant	-0.479	-0.431
	(0.342)	(0.338)
N	123	123
R^2	0.157	0.190

Note. Network size spr = number of possible alters in teacher's network in the spring. 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).

Conclusion

In this dissertation, I have presented two studies on the effects of two different approaches to managing teachers' implementation of an educational program. The over-arching motivation for both studies came from the questions of how researchers and practitioners can improve educational practice at scale, and what role scientific investigation can or should play in that endeavor.

In the first study, I investigated – and found evidence consistent with – the hypothesis that the optimal approach to educational program implementation may be a scaffolded management sequence, in which implementers first develop proficiency with a program through a fidelity phase of management before making program adaptations under a flexibility management phase. The second study was motivated by the growing body of theoretical and empirical work demonstrating the numerous ways in which teachers' social capital affects school improvement efforts. In this study, I investigated the effects of management approach on outcomes related to teachers' social capital. I found that the flexibility approach caused participants to form more intervention-related consultation ties and caused them to consult more frequently about instructional adaptation, as opposed to implementation. At the same time, the expansion of participants' intervention-related networks under the flexibility approach may have been offset by participants' shrinking consultation networks in instructional areas unrelated to the intervention. Both of these studies have implications for research on how school improvement initiatives are introduced and managed.

The contributions that each of these studies makes to the literature should be interpreted within the broader framework described in the introductory chapter for how science can be used to improve educational practice and outcomes. This framework integrates contrasting approaches to instructional management that support different views of how scientific evidence can be used to improve practice. These contrasting views of how science informs practice have implications for the research questions asked and the methods used to answer them. In this dissertation, I have begun the work of testing the extent to which these systems of research and practice – the "standardization/control" approach and the "flexibility/commitment" approach – might be integrated into a scaffolded system that could ultimately lead to improved outcomes compared to those we would find in a world in which educators, policymakers, and researchers view their work as that of choosing between these two systems.

Appendix A. Selected Spring Teacher Survey Items.

Q3.1 In this first set of questions, we'd like you to think about your literacy-related learning this school year. This learning could have taken place in any setting.
Q3.2 How much did you learn this school year about each of the following?

	Nothing (1)	Very little (2)	Some (3)	Quite a bit (4)	A tremendous amount (5)
Matching books to students for independent reading (1)	○	○	○	○	○
Teaching students a reading comprehension routine (2)	○	○	○	○	○
Engaging students' families in student literacy (3)	○	○	○	○	○
Supporting students' independent reading (4)	○	○	○	○	○
Increasing students' engagement in reading (5)	○	○	○	○	○

Q3.3 When implementing an intervention like READS, teachers learn how to improve their implementation through a variety of means. Below is a list of different types of learning experiences through which you may have learned how to better implement READS. This school year, what type of learning experience helped you the most at improving your implementation of READS?

○ Getting information about researcher-designed procedures through training or by reading the materials in the READS lesson box (1)
○ Having informal conversations about READS (2)
○ Practicing implementing strategies as described in the READS lesson box (3)
○ Experimenting with adaptations to the strategies in the READS lesson box (4)

Q2.4 In this next set of questions, we would like you to think about your literacy instruction this school year OUTSIDE OF YOUR PLANNED READS ACTIVITIES.

Q2.5 Over the past 2 months (i.e. since READS ITBS testing), to what extent did you guide students in selecting books for independent reading that were matched to their reading level and interests?

○ Not at all (1)
○ Very little (2)
○ Some (3)
○ Quite a bit (4)
○ A tremendous amount (5)

Q2.6 This school year, to what extent did you incorporate new strategies for teaching reading comprehension into your regular classroom practice (i.e. outside of your planned READS activities)?

○ Not at all (1)
○ Very little (2)
○ Some (3)
○ Quite a bit (4)
○ A tremendous amount (5)

Q2.7 Over the past 2 months (i.e. since READS ITBS testing), how much emphasis did you place on engaging students' families in student literacy (unrelated to READS)?

○ None at all (1)
○ Very little (2)
○ Some (3)
○ Quite a bit (4)
○ A tremendous amount (5)

Q2.8 This school year, to what extent did you incorporate new strategies for supporting students' independent reading into your regular classroom practice (i.e outside of your planned READS activities)?

○ Not at all (1)
○ Very little (2)
○ Some (3)
○ Quite a bit (4)
○ A tremendous amount (5)

Q2.9 This school year, to what extent did you incorporate new strategies for getting students engaged in independent reading into your regular classroom practice (i.e. outside of your planned READS activities)?

○ Not at all (1)
○ Very little (2)
○ Some (3)
○ Quite a bit (4)
○ A tremendous amount (5)

Appendix B. Alternative Modeling Strategies (Network Analyses)

For count outcomes analyzed in Tables 2 and 4 of chapter 3, residuals versus fitted values plots indicated good model fit; nevertheless, I also fit Poisson models as sensitivity analyses. For binary consultation outcomes, I fit logistic regression models (in addition to the linear probability models presented in Tables 2 and 4); these models dropped several observations due to perfect outcome prediction within some randomization strata. For the frequency of consultation outcomes, model 1 from the main text requires the assumption of an interval outcome scale; I therefore also fit an ordered probit model for frequency of READS-related consultation outcomes.

Table B1. Poisson Regression Models for READS Consultation Ties; Logistic Regression Models for Binary Consultation Outcomes.

	(1) Num. Consult on READS (Total) b/se	(2) Num. Consult on READS (Total) b/se	(3) Consult CIS Lead on READS b/se	(4) Consult CIS Lead on READS b/se	(5) Consult SC on READS b/se	(6) Num. READS Faculty Consult on READS b/se	(7) Num. READS Faculty Consult on READS b/se	(8) Num. non-READS Faculty consult on READS b/se	(9) Num. non-READS Faculty consult on READS b/se
Adaptive	0.107^{**}	0.209^{***}	0.827^{***}	1.182^{*}	1.418	0.008	0.033	$0.349^{\sim}$	0.794^{*}
	(0.033)	(0.048)	(0.237)	(0.489)	(0.882)	(0.025)	(0.037)	(0.204)	(0.342)
SC	0.373^{***}	0.547^{***}	$1.208^{\sim}$	1.844^{*}		0.120^{*}	0.172^{**}	1.019^{***}	1.544^{***}
	(0.067)	(0.061)	(0.654)	(0.932)		(0.054)	(0.054)	(0.201)	(0.330)
Net Size Spr	0.155^{***}	0.150^{***}	-0.045	-0.044	-0.455	0.208^{***}	0.207^{***}	0.001	-0.018
	(0.020)	(0.021)	(0.166)	(0.177)	(0.398)	(0.011)	(0.011)	(0.078)	(0.078)
Adaptive*SC		-0.363^{**}		-1.324			-0.108		-1.033^{**}
		(0.121)		(1.310)			(0.111)		(0.395)
Constant	0.567^{***}	0.539^{***}	-1.348	-1.557	2.144	0.152^{*}	0.146^{*}	-0.857	$-1.020^{\sim}$
	(0.125)	(0.116)	(0.875)	(0.984)	(1.899)	(0.060)	(0.060)	(0.574)	(0.550)
N	123	123	123	123	67	123	123	123	123

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs.

Table B2. Ordered Probit Models for Treatment Effects on Frequency of READS Consultation on Implementation and Adaptation.

	(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	-0.511*	-0.887***	0.644*	0.423
	(0.221)	(0.245)	(0.269)	(0.280)
SC	0.359	-0.355	0.211	-0.301
	(0.235)	(0.241)	(0.235)	(0.313)
Net Size Spr	0.008	0.027	0.070	0.078
	(0.119)	(0.126)	(0.138)	(0.140)
Adaptive*SC		1.630***		1.069*
		(0.411)		(0.433)
Constant	2.962***	3.095***	3.379***	3.432***
	(0.701)	(0.737)	(0.801)	(0.817)
N	123	123	123	123

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs.

Table B3. Poisson Regression Models for non-READS Consultation Ties; Logistic Regression Models for Binary Consultation Outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Num. Consult on non-READS (Total)	Num. Consult on non-READS (Total)	Consult CIS Lead on non-READS	Consult CIS Lead on non-READS	Consult SC on non-READS	Num. READS Faculty Consult on non-READS	Num. READS Faculty Consult on non-READS	Num. non-READS Faculty consult on non-READS	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	-0.123$^{\sim}$	-0.137$^{\sim}$	1.246**	1.184	-0.190	-0.107*	-0.131**	-0.160$^{\sim}$	-0.178
	(0.065)	(0.075)	(0.474)	(0.816)	(0.797)	(0.045)	(0.050)	(0.091)	(0.125)
SC	0.584***	0.565***	2.404**	2.321**		-0.021	-0.074	0.843***	0.823***
	(0.091)	(0.114)	(0.772)	(0.890)		(0.094)	(0.146)	(0.122)	(0.160)
Net size, spr	0.199***	0.200**	-0.117	-0.115	-0.014	0.225***	0.226***	0.194*	0.196*
	(0.060)	(0.061)	(0.212)	(0.324)	(0.525)	(0.018)	(0.017)	(0.094)	(0.095)
Adaptive*SC		0.043		0.167			0.114		0.047
		(0.180)		(1.248)			(0.181)		(0.235)
Constant	1.057***	1.058***	-3.264**	-3.245$^{\sim}$	1.065	-0.114	-0.109	0.628	0.630
	(0.302)	(0.300)	(1.195)	(1.960)	(2.632)	(0.081)	(0.084)	(0.484)	(0.482)
N	123	123	107	107	51	123	123	123	123

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs.

References

Atteberry, A., & Bryk, A. S. (2010). Centrality, connection, and commitment: The role of social networks in school-based literacy. In A.J. Daley (Ed.) *Social network theory and educational change*, pp51-76. Cambridge, MA: Harvard Education Press.

Ball, D.L, & Cohen, D.K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L.D. Hammond & G. Sykes (Ed.), *Teaching as the learning profession: Handbook of policy and practice,* pp. 3-32.

Borgatti, S.P. & Lopez-Kidwell, V. (2011). Network theory. In J. Scott & P.J. Carrington, (Ed.). *The SAGE handbook of social network analysis,* pp . 40-54, London: Sage Publications.

Berman, P. (1980). Thinking about programmed and adaptive implementation: Matching strategies to situations, pp 205-227, In Helen M. Ingram and Dean E. Mann (Ed.), *Why policies succeed or fail,* Beverly Hills: Sage Publications.

Berman, P. & McLaughlin, M.W. (1976). Implementation of educational innovation, *The Educational Forum, 40(3),* 345-370. DOI: 10.1080/00131727609336469

Blakely, C.R., Mayer, J.P., Gottschalk, R.G., Schmitt, N., Davidson, W.S., Roitman, D.B., & Emshoff, J.G. (1987). The fidelity-adaptation debate: Implications for the implementation of public sector social programs. *American Journal of Community Psychology, 15(3),* 253-268.

Bryk, A.S., & Schneider, B. (2002). *Trust in Schools.* New York: Russell Sage Foundation.

Castro, F.G., Barrera, M., & Martinez, C.R. (2004). The cultural adaptation of prevention interventions: Resolving tensions between fidelity and fit. *Prevention Science, 5(1),* 41-45.

Choo, C. W. (1998). The knowing organization: How organizations use information to construct meaning, create knowledge, and make decisions. New York, NY: Oxford University Press.

Coalition for Evidence-based Policy. (2013). Randomized controlled trials commissioned by the Institute of Education Sciences Since 2002: How many found positive versus weak or no effects. Retrieved from: http://coalition4evidence.org/wp-content/uploads/2013/06/IES-Commissioned-RCTs-positive-vs-weak-or-null-findings-7-2013.pdf

Coburn, C. E. (2001). Collective sensemaking about reading: How teachers mediate reading policy in their professional communities. *Educational Evaluation and Policy Analysis, 23(2)*, 145–170.

Coburn, C.E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher, 32(6),* 3-12.

Coburn, C. E., & Russell, J. L. (2008). District policy and teachers' social networks. *Educational Evaluation and Policy Analysis*, *30*(3), 203-235.

Coburn, C. E., Russell, J. L., Kaufman, J. H., & Stein, M. K. (2012). Supporting sustainability: Teachers' advice networks and ambitious instructional reform. *American Journal of Education*, *119*(1), 137-182.

Coburn, C.E., & Stein, M.K. (2010). *Research and practice in education: Building alliances, bridging the divide.* Blue Ridge Summit, PA: Rowman & Littlefield Publishers, Inc.

Coleman, J.S. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94,* S95-S120.

Cross, R., & Sproull, L. (2004). More than an answer: Information relationships for actionable knowledge. *Organization Science, 15*, 446-62.

Daly, A. J., & Finnigan, K. S. (2010). A bridge between worlds: Understanding network structure to understand change strategy. Journal of Educational Change, 11(2), 111–138.

Daly, A.J., Moolenaar, N.M., Bolivar, J.M., & Burke, P. (2010). Relationships in reform: The role of teachers' social networks. *Journal of Educational Administration, 48,* 359-391. DOI 10.1108/09578231011041062

Dane, A.V., & Schneider, B.H. (1998). Program integrity in primary and early secondary prevention: are implementation effects out of control? *Clinical Psychology Review, 18(1),* 23-45.

Datnow, A., & Castellano, M. (2000). Teachers' responses to Success for All: How beliefs, experiences, and adaptations shape implementation. *American Educational Research Journal, 37*, 775-799.

Dearing, J.W. (2008). Evolution of diffusion and dissemination theory. *Journal of Public Health Management and Practice, 14(2),* 99-108.

de Lima, J.A. (2010a). Studies of networks in education: Methods for collecting and managing high-quality data. In A.J. Daly, (Ed.), pp. 243-258. *Social Network Theory and Educational Change.* Cambridge, MA: Harvard Education Press.

de Lima, J.A. (2010b). Thinking more deeply about networks in education. *Journal of Educational Change, 11,* 1-21. DOI 10.1007/s10833-008-9099-1

Dewey, J. (1929). *The Sources of a Science of Education.* New York: Horace Liverlight.

Dusenbury, L., Brannigan, R., Falco, M., & Hansen, W.B. (2003). A review of research on fidelity of implementation: Implications for drug abuse prevention in school settings. *Health Education Research, 18(2),* 237-256.

Elmore, R. F. (1996). Getting to scale with good educational practice. *Harvard Educational Review, 66(1)*, 1–26.

Ferrer-Wreder, L., Adamson, L., Kumpfer, K.L., & Eichas, K. (2012). Advancing intervention science through effectiveness research: A global perspective. *Child Youth Care Forum, 41,* 109-117. DOI 10.1007/s10566-012-9173-y

Frank, K.A., Zhao, Y., Penuel, W.R., Ellefson, N., & Porter, S. (2011). Focus, fiddle, and friends: Experiences that transform knowledge for the implementation of innovations. *Sociology of Education, 84(2),* 138-156.

Frank, K. A., Zhao, Y., & Borman, K. (2004). Social capital and the diffusion of innovations within organizations: The case of computer technology in schools. *Sociology of Education*, *77*(2), 148-171.

Goldenberg, C., & Gallimore, R. (1991). Local knowledge, research knowledge, and educational change: A case study of early Spanish reading improvement, *Educational Researcher, 20(8),* 2-14.

Granovetter, M.S. (1973). The strength of weak ties. *American Journal of Sociology, 78,* 1360-1380.

Guryan, J., Kim, J.S., & Quinn, D.M. (2014). Does reading during the summer build reading skills? Evidence from a randomized experiment in 463 classrooms. *NBER Working Paper 20689*.

Hargreaves, A. (1991). Contrived collegiality: The micropolitics of teacher collaboration. In J. Blase, (Ed.), pp. 46-72. *The Politics of Life in Schools: Power, Conflict, and Cooperation.* London: SAGE Publications.

Harn, B., Parisi, D., & Stoolmiller, M. (2013). Balancing fidelity with flexibility and fit: What do we really know about fidelity of implementation in schools? *Exceptional Children, 79(2),* 181-193.

Hawley, W.D., & Valli, L. (1999) The essentials of effective professional development: A new consensus. In Darling-Hammond, L., & Sykes, G. (Ed.), The Heart of the Matter: Teaching as the Learning Profession. San Francisco: Jossey-Bass p. 127-150.

Hill, H. C. (2004). Professional development standards and practices in elementary school mathematics. Elementary School Journal, 104(3), 215–231.

Institute for Education Sciences. (n.d.). About IES: Connecting research, policy, and practice. Retrieved from: http://ies.ed.gov/aboutus/

Jackson, K.C., & Bruegmann, E. (2009). Teaching students and teaching each other: The importance of peer learning for teachers. *American Economic Journal: Applied Economics, 1(4)* 85-108.

Johnson, S.M. (2004). *Finders and keepers: Helping new teachers survive and thrive in our schools.* San Francisco: Jossey-Bass.

Kearns, D.M., Fuchs, D., McMaster, K.L., Saenz, L., Fuchs, L.S., Yen, L., Meyers, C., Stein, M., Compton, D., Berends, M., & Smith, T. (2010). Factors contributing to teachers' sustained use of kindergarten peer-assisted learning strategies. *Journal of Research on Educational Effectiveness, 3,* 315-342. DOI: 10.1080/19345747.2010.491151

Kim, J.S., Guryan, J., White, T.G., Quinn, D.M., Capotosto, L., & Kingston, H.C. (2016). Delayed effects of a low-cost and large-scale summer reading intervention on elementary school children's reading comprehension. *Journal of Research on Educational Effectiveness.*

Kim et al. (in preparation). Scaling a Research-Based Summer Literacy Program: A Randomized Controlled Trial Examining Precursors to Scale in a Fidelity versus an Adaptive Implementation Approach.

LaChausse, R.G., Clark, K.R., & Chapple, S. (2014). Beyond teacher training: The critical role of professional development in maintaining curriculum fidelity. *Journal of Adolescent Health, 54,* S53-S58.

Lee, V.E., Dedrick, R.F, & Smith, J.B. (1991). The effect of the social organization of schools on teachers' efficacy and satisfaction. *Sociology of Education, 64,* 190-208.

Lee, V.E. & Smith, J.B. (1996). Collective responsibility for learning and its effects on gains in achievement for early secondary school students. *American Journal of Education, 104(2),* 103-147.

Lortie, D.C. (1975). *Schoolteacher.* Chicago: The University of Chicago Press.

Marsden, P. V. (2011). Survey methods for network data. In J. Scott & P.J. Carrington, (Ed.). *The SAGE handbook of social network analysis,* pp. 370-388. London: Sage Publications.

Maxwell, J.A. (2004). Causal explanation, qualitative research, and scientific inquiry in education. *Educational Researcher, 33(2),* 3-11.

McDonald, S., Keesler, V.A., Kauffman, N.J., & Schneider, B. (2006). Scaling-up exemplary interventions. *Educational Researcher, 35(3),* 15-24.

McLaughlin, M.W. (1987). Learning from experience: Lessons from policy implementation. *Educational Evaluation and Policy Analysis, 9(2),* 171-178.

McLaughlin, M.W. (1990). The RAND change agent study revisited: Macro perspectives and micro realities. *Educational Researcher, 19(9),* 11-16.

McLaughlin, M.W., & Mitra, D. (2002). Theory-based change and change-based theory: Going deeper, going broader. *Journal of Educational Change, 2,* 301-322.

McMaster, K.L., Jung, P., Brandes, D., Pinto, V., Fuchs, D., Kearns, D., Lemons, C., Saenz, L., & Yen, L. (2014). Customizing a research-based reading practice: Balancing the importance of implementation fidelity with professional judgment. *The Reading Teacher, 68(3),* 173-183. DOI: 10.1002/trtr.1301

Meyer, A., Miller, S., & Herman, M. (1993). Balancing the priorities of evaluation with the priorities of the setting: A focus on positive youth development programs in school settings. *The Journal of Primary Prevention, 14(2),* 95-113.

Murnane, R.J., & Nelson, R.R. (2007). Improving the performance of the education sector: The valuable, challenging, and limited role of random assignment evaluations. *Economics of Innovation & New Technology, 16(5)*, 307-322

Nebus, J. (2006). Building collegial information networks: A theory of advice network generation. *The Academy of Management Review, 31,* 615-637.

Parise, L. M., & Spillane, J. P. (2010). Teacher learning and instructional change:

How formal and on-the-job learning opportunities predict change in elementary school teachers' practice. *The Elementary School Journal*, *110*(3), 323-346.

Penuel, W.R., Gallagher, L.P., & Moorthy, S. (2011). Preparing teachers to design sequences of instruction in earth systems science: A comparison of three professional development systems. *American Educational Research Journal, 48,* 996-1025. doi: 10.3102/0002831211410864

Pitts, V.M, & Spillane, J.P. (2009). Using social network methods to study school leadership. *International Journal of Research & Method in Education, 32,* 185-207. doi: 10.1080/17437270902946660

Popham, J.W. (1967). Instructional product development: Two approaches to training. *AV Communication Review, 15,* 402-411.

Portes, A. (1998). Social capital: Its origins and applications in modern sociology. *Annual Review of Sociology, 24,* 1-24.

Rittle-Johnson, B., & Star, J.R. (2007). Does comparing solution methods facilitate conceptual and procedural knowledge? An experimental study on learning to solve equations. *Journal of Educational Psychology, 99(3),* 561-574.

Rowan, B. (1990). Commitment and control: Alternative strategies for the organizational design of schools. *Review of Research in Education, 16,* 353-389.

Rowan, B., & Miller, R.J. (2007). Organizational structures for promoting instructional change: Implementation dynamics in schools working with comprehensive school reform providers. *American Educational Research Journal, 44,* 252-297.

Shavelson, R.J., & Towne, L. (Eds). (2002). *Scientific research in education.* Washington, DC: National Academy Press.

Slavin, R.E. (2002). Evidence-based education policies: Transforming educational practice and research. *Educational Researcher, 31(7),* 15-21.

Slavin, R.E., Madden, N.A., & Datnow, A. (2007). Research in, research out: The role of research in the development and scale-up of Success For All. In D.K. Cohen, S.H. Fuhrman, & F. Mosher (Ed). *The state of education policy research,* p. 261-280. Malwah, NJ: Lawrence Erlbaum Associates.

Spillane, J.P., Kim, C.M., & Frank, K.A. (2012). Instructional advice and information providing and receiving behavior in elementary schools: Exploring tie formation as a building block in social capital development.

American Educational Research Journal, 49, 1112-1145. doi: 10.3102/0002831212459339

Spillane, J.P., Hopkins, M., & Sweet, T. (2014). Intra- and inter- school interactions about instruction: Exploring the conditions for social capital development. Working paper. Retrieved from: http://www.distributedleadership.org/DLS/Presentations_files/Spillane_Hopkins_Sweet_Intra%20and%20Inter%20Paper.pdf

Sun, M., Wilhelm, A. G., Larson, C. J., & Frank, K. A. (2014). Exploring Colleagues' Professional Influence on Mathematics Teachers' Learning. *Teachers College Record*, *116*(6).

Sun, M., Penuel, W. R., Frank, K. A., Gallagher, H. A., & Youngs, P. (2013). Shaping Professional Development to Promote the Diffusion of Instructional Expertise Among Teachers. *Educational Evaluation and Policy Analysis*, *35*(3), 344-369.

US Department of Health and Human Services (2002). Finding the balance: Program fidelity and adaptation in substance abuse prevention.

Uzzi, B. (1997). Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly, 42*, 35–67.

Weinbaum, E.H., Cole, R.P., Weiss, M.J., & Supovitz, J.A. (2008). Going with the flow: Communication and reform in high schools. In J.A. Supovitz & E.H. Weinbaum, (Ed.), pp.68-102. *The Implementation Gap: Understanding Reform in High Schools.* New York: Teachers College Press.

Vygotsky, L.S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

Webster-Stratton, C., Reinke, W.M., Herman, K.C., & Newcomer, L.L. (2011). The Incredible Years teacher classroom management training: The methods and principles that support fidelity of training delivery. *School Psychology Review, 40(4),* 509-529.

White, T.G., Kim, J.S., Kingston, H.C., & Foster, L. (2013). Replicating the effects of a teacher-scaffolded voluntary summer reading program: The role of poverty. *Reading Research Quarterly, 49,* 5-30.