A THEORY OF ACTION FOR SUPPORTING IMPROVEMENTS IN THE QUALITY OF MATHEMATICS TEACHING ON A LARGE SCALE

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Research on the teaching and learning of mathematics has made significant progress in recent years. However, this work has had only limited impact on classroom instruction in many countries, including the U.S. For the past eight years, my colleagues and I have collaborated with mathematics teachers, school leaders, and educational system leaders in several large urban school systems in the U.S. to investigate what it takes to support large numbers of mathematics teachers in developing ambitious, inquiry-oriented instructional practices. We have conducted these partnerships as design research studies at the system level by enacting annual data collection, analysis, and feedback cycles in each school system. In doing so, we made empirically grounded recommendations to the leaders of each system each year about how they might revise their policies or strategies for instructional improvement to make them more effective. Follow-up analyses indicate that leaders in all the partner systems attempted to implement many of our recommendations.

In the course of the study, we compiled a longitudinal data set. The data we collected each year included interviews conducted with 120 middle-grades mathematics teachers, with the mathematics teacher leaders and school leaders from the participating teachers' schools, and with system leaders across several administrative units that have a stake in mathematics instruction (200 participants total); surveys completed by the mathematics teachers, mathematics teacher leaders, and school leaders; video-recordings of the 120 teachers' classroom instruction; assessments of the teachers' and teacher leaders' mathematical knowledge for teaching; audio- and video-recordings of mathematics teacher collaborative planning meetings; video-recordings of professional development; and a network survey completed by all mathematics teachers in the participating schools. We have established several teams to conduct retrospective analyses of these data that focus on the teachers' knowledge and practice, and on key aspects of the school and district contexts in the teachers work and in which they developed and revised their instructional practices. The findings of these analyses and the insights we developed while formulating actionable recommendations for system leaders have informed the ongoing revision of our initial conjectures about large-scale instructional improvement.

The resulting theory of action comprises six interrelated components. I will report our findings as they relate to each component. The first component is a coherent system that is itself comprises four elements: The instructional materials that teacher use, the professional development in which they participate, formative assessments to improve instructional improvement, and additional supports for currently struggling students. There is strong evidence that improvements in the quality of instruction are unlikely to occur unless system leaders deliberately coordinate these elements so that they constitute a system. In reporting on this component, I will describe two measures of teachers' knowledge that we developed. The first assesses the sophistication of their visions of what high-quality mathematics instruction

looks like and appears to be a leading indicator of improvement in their instructional practices. The second assesses teachers' views of their currently struggling students' mathematical capabilities and is associated with the quality of their instruction even when controlling for their mathematical knowledge for teaching.

The second component of the theory of action concerns teachers' informal advice seeking networks (i.e., who they turn to for advice about instruction and with what frequency). Our findings indicate that turning to a more accomplished colleague for advice is associated with improvements in the quality of instruction. The third component is time for mathematics teachers to collaborate that is scheduled regularly during the school day. Our findings indicate that while teacher collaborative time can support instructional improvement, it often fails to do so. In order for collaborative time to be productive, it appears essential that teachers connect students, mathematical content, and their instructional practices. The fourth component focuses on teacher leaders' practices in providing job-embedded support for other teachers' learning. Our findings concern the types of activities in with teacher leaders might engage both groups of teacher and individual teachers in their classrooms to support their learning. In addition, we have investigated the capabilities that teacher leaders might need to develop in addition to being effective mathematics teachers if they are to support their colleagues in improving the quality of their instruction.

The fifth component focuses on school leaders' practices as instructional leaders in mathematics. As background, U.S. school leaders are increasingly expected to act as instructional leaders who directly support teachers in improving the quality of their instruction. Our findings suggest that most of the school leaders in our study were not able to be effective instructional leaders in mathematics. However, we conjecture that they might be able to support mathematics teachers' learning indirectly by creating conditions such as a school culture characterized by trust that foster professional learning. The final component of our theory of action concerns system leaders' practices in supporting the development of school-level capacity for instructional improvement. I will describe two conflicting orientations to supporting improvements in students' mathematical learning that we have identified, clarify the difficulties that arise when leaders in different administrative units adopt opposing orientations, and suggest how these difficulties might be addressed.

As I will make clear, we currently conjecture that all six components of the theory of action are necessary. In addition, I will illustrate that the current research base becomes increasingly thin the further one moves out from the classroom, first to the school level and then to the system level. These observations point to a range of issues that need to be investigated as current research can provide only limited guidance to school and system leaders who are attempting to support mathematics teachers' development of ambitious, inquiry-oriented instructional practices.