Journal of Urban Mathematics Education
June 2014, Vol. 7, No. 1, pp. 7–18
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COMMENTARY

Place Matters: Mathematics Education Reform in Urban Schools

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In the inaugural issue of this journal, William Tate (2008a) outlined a few of the challenges related to research on urban mathematics education, including the need for the development of theories that take seriously the geography of opportunity. He urged scholars to "build theories and models that realistically reflect how geography and opportunity in mathematics education interact" (p. 7). This type of geospatial perspective "calls for the addition of a geographic lens that focuses on place and space as important contextual variables. A geospatial view increases our understanding of education…by framing research in the context of neighborhoods, communities, and regions" (Tate, Jones, Thorne-Wallington, & Hogrebe, 2012, p. 426). In this commentary, I plan to revisit the call put forward by Tate (2008a) and to explore some of the issues that models of mathematics education in the urban setting must accommodate, paying particular attention to mathematics education reform at the school level.

While mathematics education research has often focused at the level of the classroom (Rousseau Anderson & Tate, 2008), there are emerging calls for attention to shift from individual classrooms to consider the process of reform at the school or district level. As Gamoran and colleagues (2003) acknowledge, we have multiple "existence proofs" of individual classrooms in which teaching for understanding occurs. What we lack is a clear model of the factors that contribute to the success of those classrooms from an organizational perspective. Yet, the significance of the institutional context with regard to reform cannot be ignored. According to Cobb and Smith (2008), there is a substantial body of research that raises doubts regarding "an implicit assumption that underpins many reform efforts, that teachers are autonomous agents in their classrooms who are unaffected by what takes place outside the classroom door" (p. 234). In other words, the institutional setting matters. Investigating the role of the institution and conditions of the organization becomes crucial in order to fully understand classroom practice and to move beyond existence proofs to take reform to scale (Cobb & Jackson, 2011; Cobb & Smith, 2008).

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Taking mathematics reform to scale could involve a whole school or an entire district. However, whether school- or district-wide, the process of instructional improvement across multiple classrooms involves design (Cobb & Jackson, 2011; Cobb, McClain, de Silva Lamberg, & Dean, 2003; Cobb & Smith, 2008). Tate (2004) has asserted the need to take an engineering approach to opportunity to learn in mathematics education. Such an approach would involve a "learn to build" orientation that uses existing research to design more effective and equitable systems. This engineering orientation is reflected in the work of Cobb and his colleagues involving efforts to design change at scale (Cobb & Jackson, 2011; Cobb et al., 2003; Cobb & Smith, 2008). They acknowledge, however, that there are relatively few examples of successful design at the organizational level. Moreover, according to Cobb and Jackson (2011),

> the history of large-scale improvement efforts that involved significant changes in teachers' instructional practices is primarily one of failure. We contend that this unfortunate record is due in large part to the inability of research to inform the design and implementation of comprehensive systems of supports aimed at building and sustaining district and school capacity for instructional improvement. (p. 26)

While the need to design instructional improvement is not limited to a particular school or district type, it is arguably most critical for urban settings. There is an urgent need to develop and test models that can be used for the design of more effective urban schools and districts (Cobb & Smith, 2008; Tate, 2008a). While any model of school or district reform should involve the development of "testable conjectures about the constraints and affordances of the institutional setting" (Cobb et al., 2003, p. 21), the specific conditions of urban schools are crucial to consider. As such, my purpose in this commentary is not to report on a particular design effort. Rather, I seek to offer design considerations that are specific to urban schools. My intent is to contribute to theory- and model-building regarding urban mathematics education by outlining how the design process for mathematics reform might be influenced by the geospatial context.

Introducing the Case: Three Rivers

To help frame the discussion, I offer the following case of a school that I am calling Three Rivers.[1] Three Rivers Middle and High School is located in a large urban school district in the southern United States. The school is similar, in many respects, to other schools in the neighboring community and larger district. The

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[1] Some of the information about the school, district, and community is drawn from local news sources. However, to include these sources in the reference list would potentially compromise the anonymity of the school and teachers. For this reason, I indicate when information comes from local media outlets but do not list the articles in the reference list.

school population is 98% African American and 2% Latina/o. Eighty-nine percent of students in the school are categorized as "economically disadvantaged" by the state. And similar to several schools in the surrounding community, Three Rivers has not fared well under the current accountability system. Student achievement, particularly in mathematics, has been significantly below district and state averages. The school has struggled to consistently keep pace with annual growth benchmarks established by the state (sometimes meeting the growth targets one year and missing them the next). Comparable to other urban schools described in the mathematics education literature, instruction at Three Rivers does not, on the whole, reflect the reform goals of teaching for understanding that mathematics educators have been promoting for several years (Cobb & Jackson, 2013; Gamoran et al., 2003; Spencer, 2012). Observations of mathematics classrooms reveal a general pattern of "traditional" instructional practices (e.g., teacher modeling of procedures followed by student independent practice). Although the school has adopted curricular materials that support teaching for understanding, these materials are often supplemented (or supplanted) by worksheets or previously adopted textbooks that align more closely with the standardized test. In all fairness, however, there are glimpses of teaching for understanding at Three Rivers, but it has not yet taken hold in a systemic way. Moreover, the practices associated with teaching for understanding are largely viewed by teachers as in conflict with preparing students for the high-stakes standardized tests—tests that tend to shape curricular, instructional, and assessment decisions through the school year. Thus, I would argue that Three Rivers is an example of a school in need of a design. Improvement of the quality of instruction will require that the localized and intermittent examples of teaching for understanding spread across the school and become part of the institutional fabric such that teaching for understanding becomes one of the taken-for-granted characteristics of the organization.

Mathematics Reform in Urban Schools

There are existing theories of how this systemic reform might be accomplished (Gamoran et al., 2003; Tate & Rousseau, 2007). For example, Cobb and Smith (2008) have outlined a theory of action for designing schools and larger organizations for instructional improvement. Their theory encompasses five components intended to provide the supports necessary to establish reform at an institutional level: (a) a coherent system of supports for instruction; (b) teacher networks; (c) mathematics coaches' roles in supporting teacher learning; (d) school leaders' practices; and (e) district leaders' practices. As Cobb and Jackson (2011) note, their theory of action includes multiple components and interactions. They hypothesize that all of the components must be established for maximum instructional improvement. Moreover, the improvement efforts aligned with these actions should be based on "useful knowledge about the relations between the institutional settings in which teachers work, the institutional practices they develop in those settings, and their students' mathematical learning" (Cobb & Smith, 2008, p. 249).

Understanding the impact of the institutional setting is arguably of particular importance when considering the design of instructional improvement in urban schools. For example, Gamoran and his colleagues (2003) reported on the process of mathematics and science reform at six different sites located in various parts of the United States. The authors divided the six cases into three groups: sites that met the challenges of reform; sites that initially met the challenges of reform but did not demonstrate long-term growth or stability; and sites that failed to meet the challenges of reform. Notably, three of the six sites were located in urban school districts. Two of the urban sites made up the least-successful category—those cases where little progress was made toward reform. The third urban site fell into the middle category—reform was initially successful but did not sustain or grow over time. The bifurcation of the sites into successful or relatively successful suburban or rural-suburban sites and less successful urban sites is noteworthy and points to the need to take seriously the specific factors shaping reform in urban schools. According to Gamoran and colleagues (2003), the cases of the two unsuccessful urban sites "point to the difficulties in meeting the challenges so prevalent in urban environments" (p. 104). In particular, Gamoran and his colleagues highlight the obstacles faced by teachers in these schools in light of various district policies, particularly those related to assessment. The role of testing constrained both time and curriculum in the urban sites as they "contain a built-in tension between accountability systems and building resources to support teaching for understanding" (Gamoran et al., p. 169). Addressing this tension is one of the challenges of design for mathematics education in urban schools (Cobb et al., 2003).

Another issue of particular importance for the reform of urban schools involves the characteristics of the teacher population and the capacity that teachers in urban schools bring to the reform process. Teacher preparation, credentialing, and experience are important factors with regard to instructional effectiveness (Darling-Hammond, 2010; Rousseau-Anderson & Tate, 2008; Tate, 2008b). Yet, these characteristics of teacher capacity, particularly in urban schools, are influenced by a variety of factors, including teacher shortages, teacher turnover, and the presence of alternative pathways to teaching.

Shortages of qualified teachers are clear impediments to instructional improvement in mathematics and are of particular concern in urban schools. According to Ingersoll and Perda (2009), "contemporary educational thought holds that one of the pivotal causes of inadequate school performance is the inability of schools to adequately staff classrooms with qualified teachers, especially in fields such as mathematics and science" (p. 1). In fact, Ingersoll and Perda report that, of the school subjects included in their national study, mathematics experienced the most serious hiring and recruitment problems. The results indicated that 54% of secondary schools had job openings for mathematics teachers and about 41% of these indicated serious difficulties filling these openings. In other words, 22% of all secondary schools in the national sample had difficulties filling mathematics positions with qualified teachers.

Yet, these shortages were not driven as much by lack of production of new teachers as by turnover of existing teachers: "Turnover is a major factor behind the problems that many schools have staffing their classrooms with qualified mathematics, science, and other teachers" (Ingersoll & Merrill, 2013, p. 23). Moreover, we know that turnover is not equitably distributed across states, districts, or schools within districts. According to Ingersoll and Merrill (2013), 45% of teacher turnover of all public schools in 2004–05 took place in just 25% of schools. High-poverty, high-minority, urban, and rural schools had the highest rates of turnover. Yet, as noted in the cases highlighted by Gamoran and colleagues (2003), teacher turnover can disrupt professional communities in the process of reform. Thus, as we consider the factors shaping mathematics reform in urban schools, the role of teacher turnover must be part of the model.

One strategy for addressing turnover and the subsequent teacher shortfall in hard-to-staff schools and districts has been to provide alternative pathways to teaching. These pathways reduce the requirements for initial entry to teaching, allowing teachers to begin teaching before completing all of the requirements for licensure (Clark et al., 2013; Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Heilig & Jez, 2010). One of the primary examples of these alternative pathways is Teach for America (TFA). According to its website (www.teachforamerica.org), the organization serves 48 sites, including several of the nation's urban school districts. While the overall number of TFA corps members is small, relative to the larger population of U.S. teachers, the expedited pathway to teaching represented by TFA and the concentration of the program in high-minority, low-income school districts makes TFA a noteworthy entity in any discussion of reform and teacher capacity in urban schools.

It is beyond the scope of this commentary to review the recent research on the effectiveness of Teach for America and other alternative pathway programs. However, it is worth noting that reports of teacher effectiveness have been mixed. Some researchers have concluded that TFA corps members are making a positive impact on mathematics teaching and learning in the high-needs schools that they serve and are more effective than teachers from other alternative pathway programs or traditional teacher licensure programs (Clark et al., 2013; Kane, Rockoff, & Staiger, 2008). Other researchers have not found such positive outcomes when comparing TFA corps members to other teacher populations, particularly when TFA teachers are compared to completers of traditional teacher preparation programs. According to Darling-Hammond and her colleagues (2005), large, well-controlled, longitudinal studies have shown that "teachers who entered teaching without full preparation…were significantly less effective when they started than fully prepared beginning teachers working with similar students" (p. 47).

While the results have not been entirely straightforward, two points are worth highlighting when considering how programs such as TFA might fit into models of school-level mathematics reform. First, even in studies in which the effectiveness of TFA corps members is described as positive, relative to other populations, their longevity is not comparable to traditionally prepared teachers. For example, in a study by Kane and colleagues (2008) of New York City schools, the 5-year retention rate for traditionally certified teachers in the population was approximately 50%, compared to only 18% for TFA corps members. Thus, one consideration with regard to the role of TFA in urban mathematics education involves the issue of turnover.

Yet, a second issue raised by the research on TFA and other alternative pathway programs is the significance of the local context and larger teacher supply in that setting. For example, Darling-Hammond and colleagues (2005) note that TFA operates in districts that hire many uncertified teachers. "Our analyses suggest that in contexts where many teachers have little preparation and where there is high turnover, TFA may make a positive contribution" (p. 21). Darling-Hammond and her colleagues observe that, because TFA corps members make a two-year commitment, they can actually provide more stability than the existing teacher pool in some urban districts. Similarly, while Kane and his colleagues (2008) acknowledged the much higher turnover rate of TFA corps members over 5 years, they argued that the relative effectiveness of TFA teachers potentially offsets this turnover. In both cases, these conclusions point to the importance of understanding teacher capacity in context. The interplay of teacher shortages, teacher turnover, and the strategies that are employed to address those shortages, particularly in the schools serving low-income students and students of color, contribute to a complex picture with regard to teacher capacity and mathematics reform in urban schools. Models of urban mathematics education must account for this complexity. Moreover, design strategies for organizations must also be sensitive to these forces shaping teacher capacity.

A Return to Three Rivers

Similar to other urban schools, the teacher supply in the district in which Three Rivers is located reflects national patterns of shortages in secondary mathematics. For example, according to a local media source, school district officials reported that over 80 vacancies in mathematics were posted in the 2013–14 school year with only 20 certified applicants. Moreover, this number of vacancies does not include local charter schools and the schools that are operated by the state, as these schools are responsible for their own hiring. In fact, at one point during the 2013–14 school year, a local organization that serves as an umbrella for teacher recruitment for the area listed 162 open positions in mathematics within its partner schools.

The district in which Three Rivers is located, similar to other urban districts, has turned to alternative providers to fill teacher positions. Specifically, national organizations such as Teach for America and the New Teacher Project operate as providers of local teachers, with TFA as the largest of the alternative route programs. While a state evaluation of teacher preparation highlights the effectiveness of TFA relative to other teacher preparation programs (including most of the state's traditional university-based programs), the state report also indicates that only 37% of the TFA corps members included in the evaluation continued teaching past the 2-year teaching obligation.

These larger trends within the district with regard to teacher supply and credentialing in mathematics are reflected in the teacher population at Three Rivers Middle and High School. At the start of the 2013–14 school year, only three of the nine mathematics teachers held a regular teaching license (one teacher held a license in secondary mathematics and the other two were licensed for the elementary and middle grades). Four of the nine teachers who started the 2013–14 school year teaching mathematics were TFA corps members.[2] In addition to the TFA corps members, three teachers were employed on a "transitional" license. This emergency credential allows individuals with undergraduate degrees to teach for up to 3 years while completing the requirements for licensure. With regard to experience, seven of the nine teachers who started the 2013–14 school year at Three Rivers were within their first 3 years of full-time teaching. Thus, the majority of the school's mathematics teachers had not completed traditional teacher preparation programs before beginning teaching, and, as a whole, they were relatively inexperienced. In addition, the school reflected patterns of teacher turnover evident in urban districts. Two of the teachers who began the 2013–14 school year left mid-year. A licensed teacher who had previously taught at Three Rivers replaced one of the teachers. A TFA corps member, who had been teaching at the elementary school level, replaced the other teacher (bringing the number of TFA corps members to five). In this way, several of the larger trends with regard to

[2] One of the TFA corps members had completed an undergraduate teacher training program and held a regular teaching license. As such, this individual is represented in the count of TFA corps members and in the number of licensed teachers.

teacher supply, teacher turnover, and alternative pathways to teaching are evident in the case of Three Rivers.

Before considering what this means for the task of design, I should also raise additional geospatial considerations relevant to this case. Three Rivers Middle and High School is located in a larger community, which I refer to, by the same name. The community of Three Rivers is an incorporated area of approximately 40,000 residents within a larger U.S. city. Over a period of several years, the Three Rivers area has suffered from the loss of large plants that provided blue-collar jobs for many in the community. According to a local newspaper, the unemployment rate in the community is 17%; and 6 out of 10 children in the community of over 40,000 live within the federal definition of poverty.

The community is served by three high schools. The graduation rates of these schools for the 2012–13 school year were 58%, 41.6%, and 84.1%. Only one of the three schools approached the statewide graduation rate of 86.3%. These relatively low graduation rates are also reflected in post-secondary attainment in the community. According to the U.S. Census Bureau, in the zip code that encompasses most of Three Rivers, only 45% of the population of residents 25 years or older hold a high school diploma, and only 7.1% of residents hold a Bachelor's degree or graduate/professional degree. Moreover, these post-secondary outcomes are consistent with achievement patterns in the three community high schools. Average ACT composite scores for eleventh graders at the three schools during the 2012–13 school year were 14.6, 13.9, and 16.2, compared to the state average of 19.1.

Yet, the struggles of the Three Rivers schools are not only reflected in the relatively low graduation rates and levels of post-secondary attainment. Under the current accountability system within the state, schools whose achievement levels put them in the bottom 5% statewide are subject to takeover. During the 2012–13 school year, 83 schools in the state were identified in the bottom 5%. Of these 83 schools, 12 were located in the Three Rivers community. Thus, although Three Rivers represents only about 0.6% of the state population, their schools made up over 14% of those in the lowest-performing bracket. In fact, 12 out of the 18 elementary, middle, or high schools located in Three Rivers were in the bottom 5% of schools statewide.

Building Models of Urban School Reform in Mathematics

So, what does this mean for research on urban mathematics education? I submit that the case of Three Rivers, while far more complex than I have been able to describe in this space, points to some of the issues that models of urban mathematics education must be able to accommodate. Design strategies and theories of change for urban schools must account for these influences on the institution.

First, efforts to understand mathematics reform in urban schools must take into account the role of policy at various levels. As Cobb and Smith (2008) note, school and district policies are part of the institutional setting that shapes teacher instructional practice. Moreover, the case of Three Rivers is not unlike the urban sites described by Gamoran and colleagues (2003) in the manner in which state policies regarding school and teacher accountability appeared to influence reform (or the lack thereof). However, it is important to note that the institutional settings of urban schools, such as Three Rivers, also intersect with broader policy initiatives that, while sometimes instantiated through state or district policies, can take on a life of their own. As Lipman (2012) has previously outlined in this journal, for example, urban mathematics education operates within a larger (neoliberal) reform agenda. The increased presence of Teach for America as well as the state takeover of low-performing schools can be considered as examples of this larger reform agenda within the local Three Rivers context. It would be impossible to ignore the role of these policy conditions in any theory or model of urban mathematics education that takes seriously the dynamics of reform in urban schools. Moreover, the design of instructional improvement must be informed by knowledge of this policy context.

In addition, I submit that the case of Three Rivers lends further support to Tate's (2008a) call for geospatial models of urban mathematics education. For example, while the issues of assessment and accountability likely affect schools statewide, the specific pressures experienced by teachers at Three Rivers Middle and High School must be understood in the context of the surrounding community. Twelve of the 18 schools in Three Rivers are already subject to state takeover, with several schools in the area being turned over to charter management organizations in the upcoming school year. This situation raises key questions related to the local school context and the institutional setting, and these questions would potentially impact the design of interventions at this site. In particular, what impact does the proximity of multiple takeovers have on teachers' and administrators' levels of comfort with respect to mathematics reform? Given the school restaffing that accompanies takeover, how willing are teachers and leaders to shift from a test-driven, teacher-centered pedagogy in the midst of these stakes? My point in raising these questions is not to provide a justification for lack of reform. Rather, my intent is to highlight the contextual factors that we must take into account as we build models of school change. Only by considering the specific conditions of this school's geographic setting can we fully understand the factors shaping mathematics reform and instructional improvement in this location.

Moreover, knowledge of the geospatial context also helps us to recognize the intergenerational factors shaping reform in this setting. For example, just as the teacher capacity conditions cannot be understood without knowledge of teacher supply, the shortage of mathematics teachers must be situated in an intergenerational context. The larger school district in which Three Rivers is located serves over 100,000 students. A recent newspaper article reported that, of those, fewer than 6% of eleventh graders are considered "college ready" on the basis of ACT benchmarks. And, as previously noted, fewer than 8% of adults in the Three Rivers community have undergraduate degrees. In this setting, the mathematics teacher shortage is a predictable consequence of long-term under-education. It is perhaps not surprising, then, that less than half of the mathematics teachers at Three Rivers Middle and High School are from the local area, and none are from the community itself. What impact does this lack of connection to the community have on mathematics teaching and learning at this school? And, more generally, how can we situate the intergenerational impact of chronically underperforming schools within models of school reform and the design of interventions?

Conclusion

In summary, I argue that theories or models of urban mathematics reform must be sensitive to policy, situated geospatially, and attentive to the intergenerational influence of the local context. Our efforts to design interventions for schools such as Three Rivers will potentially be limited in their long-term impact if considerations of these factors are absent. For example, models of mathematics reform at scale include professional development as a key component (Cobb & Smith, 2008; Gamoran et al., 2003; Tate & Rousseau, 2007). Yet, the design of professional development in settings such as Three Rivers must be informed by knowledge of the geospatial context in order to fully account for the factors shaping reform. Each unique geospatial context raises particular design issues. How would we leverage professional development to promote mathematics reform in a high-pressure accountability context? What are the design considerations for professional development involving the various actors (teachers, school leaders, coaches) in a setting in which the accountability stakes are so high?

Similarly, a model that includes consideration of the contextual factors shaping teacher capacity raises particular design questions. Given the interplay of teacher shortages, alternative pathways to teaching, and teacher turnover, how do we design effective professional development for urban schools? How do we design professional development opportunities that can leverage reform in a context in which teachers possess limited teaching experience or previous preparation? Additionally, how can professional communities sustain themselves in the midst of substantial teacher turnover (Gamoran et al., 2003), particularly given that some of the turnover is a common outcome of the alternative teaching pathways? Finally, what are the intergenerational considerations of teacher capacity as they shape urban mathematics reform? More to the point, what are the intergenerational solutions for issues of limited teacher capacity in urban schools?

"Place matters" in the study of urban mathematics education (Hogrebe & Tate, 2012). Schools such as Three Rivers are situated at the nexus of a myriad of factors that influence the capacity to move from "existence proofs" of classrooms to whole-school implemention of mathematics reform. Yet, as Cobb and Jackson (2011) assert, "the issue of how to support instructional improvement on a large scale continues to be under-researched. As a consequence, research can currently provide only limited guidance to district and school leaders who aim to improve the quality of mathematics teaching" (p. 6). Thus, there is a need for research to support model development and testing to help us "learn to build" in urban spaces (Tate, 2004, 2008a). Until we construct more nuanced models that are sensitive to all of these factors operating in urban settings and their multiple interactions, we will continue to find that urban schools, such as Three Rivers, populate the "failed" category of urban mathematics reform (Gamoran et al., 2003). What I have learned from the example of Three Rivers is the need for models and designs that take into account the fact that *place matters*.

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