IMPLEMENTING STANDARDS INITIATIVES IN MATHEMATICS AND SCIENCE WITHIN A LARGE, URBAN DISTRICT:

PRINCIPAL PERSPECTIVES ON SUPPORTS AND BARRIERS

JEANNE CENTURY
AMY CASSATA
DEBBIE LESLIE

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STUDY OVERVIEW

This study explores and describes variation in schools enacting district initiatives for achieving Common Core State Standards for Mathematics (CCSS-M) and Next Generation Science Standards (NGSS) outcomes, and possible explanations for this variation in Chicago Public Schools (CPS). CPS is a large urban district with over 500 schools and about 400,000 students, divided into 13 regional networks. This paper shares findings from one part of that study.

In addition to questionnaires administered to teachers and principals as well as document analysis and interviews with district and network leaders, we interviewed 12 principals from schools that varied by grade level, enrollment, selectivity, "STEM school" designation, student demographics, and level of CCSS-M and NGSS-related supports provided by the district and their partners. Our research questions were as follows:

1. What are the schools' enactments of the district plans for implementing the standards?

2. How do differences in schools' organizational capacities and contexts shape their enactment of the district's plans for implementing standards?

The findings reported here emerged from the principal interviews and focus on the second research question. We describe the supports and barriers that the principals reported have directly influenced their abilities to participate in and implement various components of the district plans for bringing about standards-aligned instruction in mathematics and science. We have also identified a number of other principal, school, and district factors that furthered or inhibited their efforts.

THEORETICAL FRAMEWORKS FOR UNDERSTANDING FACTORS THAT INFLUENCE IMPLEMENTATION

We take the stance that district adoption of standards in itself does not bring about changes in instruction that will lead to improved student outcomes. Rather, we hypothesize that success of standards-based reform resides in the enactment of district plans (i.e., policies and practices) intended to change instruction, which then lead to standards-based student outcomes. Since their inception in 2010, the CCSS-M and NGSS, by design, have not advocated the use of specific approaches for supporting standards-aligned instruction, leaving these decisions to states and localities (Common Core State Standards Initiative, 2010). In response, districts have instituted a range of different approaches to realize the goals of the standards, such as: offering new or different professional learning opportunities for teachers and administrators; making changes to curricular content and/or pedagogy; communicating new or different expectations for teachers and administrators; and making changes related to assessment. Understanding the success of any standards-based reform effort, therefore, will depend on the type and combination of approaches selected by districts and the extent to which those approaches are successfully taken up by schools and teachers.

In this project, we regard Chicago Public Schools' plans for achieving the CCSS-M and NGSS, rather than the standards themselves, as the "intervention" of interest. This focus is grounded in our understanding of interventions to be any endeavors (e.g., programs, policies, strategies, methods) that specify changes in behavior or practice for the individuals/end users enacting them (Century & Cassata, 2014). While the standards articulate *the desired student outcomes*

that districts should strive for, the district plans articulate *what teachers and administrators should know or do differently in order to accomplish those outcomes* (e.g., attend more workshops, participate in a new professional learning community, use a new curriculum). We agree with the widely accepted view that educational interventions are by and large composed of multiple components (i.e., features, building blocks, ingredients, elements) (Abry, Hulleman, & Rimm-Kaufman, S.E., 2015; Domitrovich et al., 2008) that work together (or not) to produce desired outcomes. Accordingly, our approach in the present study has been to identify and clearly describe all of the plan components that CPS has instituted to achieve the goals of the CCSS-M and NGSS, so that we may note which aspects have been taken up (or not) by schools and **teachers**.

In understanding *why* particular components of the district plans are enacted or not, and to what extent, we turn to an overarching theory of "influential factors," or contexts, conditions, and characteristics that influence intervention implementation. Four key spheres of influence have been identified across multiple disciplines: factors related to the individual end-user (e.g., teacher, administrator), the organization (e.g., school, district), the external environment (e.g., community, state), and the attributes of the innovation itself (Century & Cassata, 2016; Damschroder et al., 2009; Greenhalgh et al., 2004). Implementation research has recently acknowledged that factors from all of these spheres can be brought to bear on the success or failure of an intervention and have varying degrees of impact over time (Century & Cassata, 2014). While not part of the innovation itself, understanding the influence of a range of factors within each sphere of influence can develop our knowledge about the most conducive contexts and conditions for educational improvement. In the present study, our factor framework (Century & Cassata, 2016) guided our analysis of principal interview data, providing us a structure for organizing and categorizing the supports and barriers that principals experienced in their efforts to enact the district plans for achieving the CCSS-M and NGSS. factors that furthered or inhibited their efforts.

METHODS

In the present study, in order to understand if, how, and why adoption of mathematics and science standards would lead to better and more equitable student outcomes in Chicago Public Schools, a necessary first step was to identify the combination of approaches that CPS central office had instituted to support standards-aligned instruction in mathematics and science, respectively. The research team conducted a document review and targeted interviews with six district leaders including the Director of Mathematics, the Director of Science and two specialists from each department. We also interviewed two main university partners that worked closely with central office staff to conceptualize and implement the chosen approaches. These data, in combination with feedback from district leaders, were synthesized to produce two comprehensive summaries of plan components (which we refer to as the "math plan" and the "science plan") representing the district's efforts to support teachers and schools to bring about instruction aligned with the CCSS-M and NGSS (see Figures 1 and 2). We consider these math and science plans to be "interventions" that have been enacted by schools in varying degrees.

Subsequently, purposive sampling with the intention of ensuring school variability with regard to size, grade, geography and specialty was used to recruit principals for interviews; 12 principals across five networks consented to participate. In winter 2017, we conducted a 60-minute structured interview with each principal to a) explore the extent to

which each school was enacting the specific components of the CPS plans for CCSS-M and NGSS attainment, and b) identify key supports and barriers influencing their school's implementation of each set of approaches. Each interview was audio-recorded and transcribed.

ANALYSIS

Interviews were coded and analyzed with the qualitative analysis software HyperResearch using an iterative combination of deductive and inductive strategies. Using an open coding scheme, we identified emergent factors (subsequently categorized into individual, organizational, or environmental influences informed by the theoretical framework) associated with school implementation of each district plan element. Subsequently, we identified each as a supporting or inhibiting factor. We identified themes present across schools as well as factors unique to particular schools.

RESULTS

CPS plans for accomplishing the CCSS-M and NGSS. In CPS, the CCSS-M were adopted and implemented district-wide beginning in 2014-15 (planning began in 2012-13). In comparison, the NGSS were adopted and implemented district-wide in 2016-17, with a pilot year in 2015-16. As several district plan components have evolved over time, the plan summaries referenced in this study reflect a bounded time frame (2013-2017) within which achieving standards-based mathematics and science instruction was an explicit focus for the district. The district mathematics plan (Figure 1) included an over-arching district strategy of clear, consistent messaging about "high quality mathematics instruction" across all CCSS-M initiatives. The district science plan (Figure 2) included a guiding mission and vision statement. Other key elements present in both CCSS-M and NGSS plans included: 1) Network and school administrator professional development for the purpose of building capacity to lead high-quality mathematics and science instruction; 2) Teacher professional development for the purpose of implementing high-quality mathematics and science instruction; and 3) A repository of tools and resources for instruction, assessment, and evaluation (most of which were available online on a district website called the Knowledge Center). The Science plan also included professional development for district partners (e.g. museum partners and collaborating university partners) to promote a consistent message and approach as these partners provided professional development for teachers within the district through various externally funded initiatives. For both CCSS-M and NGSS, administrator and teacher professional development was designed as a tiered set of opportunities (i.e. workshops and collaboration structures) offered to (but not generally required of) all staff, and additional content training for teacher leaders in all networks (for mathematics) and selected networks (for science). Some networks received coaching for mathematics as well. Specific opportunities varied depending on the year.

The district plans for creating standards-based (CCSS and NGSS) instruction both emphasized providing teachers and administrators with opportunities for professional learning related to the standards. As part of these opportunities, the district enacted a teacher leader strategy in which the district provided professional development experiences for principal-designated teacher leaders (who were typically full-time classroom teachers, not released for leadership duties), with the expectation that they would be ambassadors in their schools for the new content and practices they were learning. According to the plans articulated by the district math and science

leadership, it was not expected that teacher leaders would formally provide school-based professional development; rather, they were expected to find ways to communicate and share their learning about the content and pedagogical practices associated with the CCSS or NGSS with their colleagues (e.g., by explaining new approaches at grade-level meetings, sharing resources, and/or allowing teachers to observe them as they implement new practices) and to advocate for these practices within their schools. The math plan emphasized teacher leadership as the key mechanism for reaching all schools and all teachers in the district. The science plan also featured a teacher leader approach, but this model was only implemented in selected networks due to funding constraints.

Although the district's mathematics and science plans shared key components, they were not executed simultaneously or with the same amount of resources. Some resources supporting enactment of the district plan came from within the district, while other resources came from external funders. For example, local foundations supported university partners to collaborate with the district departments of math and science to develop and implement portions of their plans and to work directly with teacher leaders in particular district networks as part of these plans. These networks came to be referred to as "deep support networks."

Supports and barriers to implementing math and science plan components. Principals identified a range of supports and barriers tied directly to a number of math and science plan components. Sometimes supports and barriers were shared across mathematics and science implementation efforts while at other times they were unique to only one or the other. Below, we describe the plan components that were most frequently mentioned by principals when asked about supports and/or barriers. The section below is organized into four categories, each representing one of the larger categories of plan components: 1) Instructional Materials, 2) Principal Professional Development, 3) Teacher Professional Development, and 4) the Knowledge Center. Following this, we describe the factors that emerged as most influential to principals' efforts in working toward standards-aligned mathematics and science instruction in their schools.

Supports and barriers related to standards-aligned instructional materials. From the perspective of principals, the starkest difference between the district's mathematics and science plans could be seen in the realm of mathematics and science instructional materials. Most commonly, the principals' discussions of the materials revolved around the presence (or lack thereof) of a list of district-approved instructional resources (i.e., curricular materials).

Mathematics. The district's "rollout" of the CCSS began in 2014. This was followed by a list of district-recommended CCSS-aligned mathematics instructional materials in 2015 to inform curriculum selection and purchasing for the 2015-16 school year. The district also created opportunities for school personnel to attend a curriculum fair to inform their selection of math curricular materials and to attend curriculum-specific professional development aligned with their curricular choice. Some principals purchased new instructional materials before the recommended list came out, while others made their purchases after the list; their points of view were shaped, to some extent, by this timing. For example, one principal spoke about the good fortune of choosing their mathematics materials before CPS distributed the list because this principal felt that having the teachers identify and select their curriculum "helps I think with ownership and buying in and when you're making a shift." This principal, however, was in the minority because the lack of a list at the outset of

adoption was considered a barrier to implementation for most other principals. Those referencing barriers hearkened back to when the district began efforts to align instruction to the CCSS-M without having a set of recommended instructional materials, leaving principals uncertain about what to use. One principal took their staff through a selection process, relying on the staff's expertise, but others felt that "introducing Common Core before there were programs we were allowed to use that were aligned to Common Core was a barrier." Consistent with this, another principal who purchased materials after the list was distributed spoke about the ease of having a list, working through the list, and having teachers select from the CPS-recommended materials.

Science. Even though some principals found themselves moving forward with selecting a mathematics curriculum without the benefit of a list of recommended materials, a list was produced within a year of initial implementation. In contrast, the district has not produced a list of recommended NGSS-aligned science materials. Ten of the twelve principals interviewed identified the lack of such a list as a barrier; it was, by far, the most frequently identified challenge to their teachers engaging in standards-aligned instruction. With a precedent set for the district providing a list of recommended materials for mathematics, principals sought the same guidance for science. One noted: "the district really needs to put out a list of approved curricula and let us choose from that list. They've done a great job with that with literacy and with math in the past few years. I think it's about time like science and social studies do that as well." In one principal's own words, they were "in limbo" without a foundation to build from.

Even thought there was no list of the new recommended materials for science, the district did provide some resources and guidance about how to move or adjust science curricula and kits from the district's pre-NGSS recommended science scope and sequence to better align with the NGSS. However, not all principals were aware of these suggestions. One principal recalled understanding that the previously-used science kits were, to some extent, aligned with the NGSS but that recollection was quickly followed with the disappointed perception that teachers were no longer able to access these kits from the district lending program. Another principal referred to these same materials as something from the past noting that "[the science materials] doesn't support [NGSS] so you're on your own….we don't have the curriculum materials, so my teachers have to pull, we have to order, and we have to really plan that out" and later noted "we're left to do the footwork."

The lack of materials seemed to have exacerbated the principals' already-limited focus on science instruction in the wake of the adoption of the CCSS, which brought increased principal attention to literacy and math. Still, other principals initiated their own efforts in developing NGSS-aligned instructional materials. They drew from resources they already had or initiated school-based efforts to seek out resources and worked to ensure those resources were standards-aligned. In some cases, principals turned to their teachers to take the reins of the school-based effort. In one case, a principal was grateful for a teacher who had taken the initiative to move the school forward and in another, the principal deferred to the teachers noting, "I always feel like my teachers are the ones implementing it. They have to choose it."

The challenge that came from the lack of a recommended science curriculum list was compounded by the fact that principals interpreted what was expected of them differently. For instance, one principal felt that there was no longer a need or expectation for a curriculum.

Rather, they explained, you start with the standards and then draw from different resources; "you need to pull from the internet. You need to pull from books. You need to pull from things that are happening in real life." With this point of view, the principal explained that the NGSS was a challenge for the veteran teachers who were used to being given the curriculum and told "this is what you're going to use." Other principals had a very different understanding and approach in that they understood that pulling together a whole curriculum is not trivial. Referring to expert curriculum developers, one principal noted, "if experts are spending all of their time trying to do one thing [write curriculum], how do you expect teachers to do a whole year [of curriculum] in way less time?"

The relatively positive experience principals had with selecting their CCSS-aligned mathematics curricula stood in stark contrast to their experience with science. They wanted the same kinds of supporting resources. As one principal explained, "it wasn't funded or supported or mandated in any way, but as a principal…you have to make sure that the people have the resources in order to now teach these standards. Another concurred, "I think that there is something to be said for having a curriculum that all students are working off of… one of the barriers is, you have to teach this concept and yet we don't have the curriculum materials." Even principals who accepted and embraced the idea of building their own curriculum expressed a need for more support and guidance looking for foundational information about the process and what they could expect.

Supports and barriers related to principal professional development. Principal professional development was a core component of the district's mathematics and science plans to nurture the development of standards-aligned instruction. With regard to both mathematics and science, principals participated in professional development and found it to be useful, but in both subjects, they also felt it was insufficient. This was particularly true for the principals who did not have science or mathematics backgrounds. One explained, "I think as a principal without a math background, I got training, but there was no follow up to support me, so that's been a barrier…I needed my hand held for a while and there was no hand holding." And in science, a principal noted "I think they've all been helpful. That's not my background so I do…find value in just looking at the standards, reading the standards, doing a task related to the standards and hearing from the district reps about it." Another principal felt that the support wasn't differentiated enough to mesh with principals' different priorities.

The perceived insufficiency of some the principals' professional development experiences, particularly in science, was evident in their comments. One principal recounted a professional development session in which they learned about a "really lengthy rubric" of what standards-aligned instruction should looks like in science, only to have the remaining professional development for the year canceled, leaving them faced with following up on their own. This principal continued, "I don't know what you would consider the district "look-fors" for NGSS standards. I have not had anyone come out, though I've requested it since last year." Another principal directly explained, "With NGSS, it's really been an uncomfortable transition. We've not received as much professional development as we did for literacy or math."

Supports and barriers related to teacher professional development. As with their comments about the professional development for principals, principals viewed the teacher professional development provided by the district and its

partners as supportive of their standards-implementation efforts. They specifically appreciated the professional development sessions for teacher leaders (called Teacher Leader Institutes, or TLIs) as well as other experiences (e.g. support from district central office personnel during professional development days). Not surprisingly then, the negative comments made about teacher professional development came from principals who were disappointed by instances when the district canceled already-scheduled professional development, leaving the teachers and principals with limited additional opportunities to learn. (These cancellations occurred in a single year and were related to budget cuts and furlough days across the district; they were not specific to math and science professional development.)

Principals' comments about the teacher professional development sometimes included their understanding of and opinions about the teacher leader model. Overall, opinions were wide-ranging in both the mathematics and science contexts. Some principals were very positive, lauding the opportunities for their teacher leaders and the positive outcomes of those opportunities. One principal explained, for example, "I think that's an excellent approach to allow the teachers, the teacher leader way of doing it because these are individuals who [staff] can identify with and [teacher leaders] are readily accessible to them." This point of view was not universal, however. One principal noted that "nobody" wants to go to the Teacher Leader Institutes, and another lamented that they don't have enough teachers to free up to attend the TLIs. Time was not only an issue for teachers being away from classrooms, but also pertained to finding or creating structured time for teacher leaders to share learning with colleagues.

Within the context of conversation about the teacher leader model, the disparity between mathematics and science emerged as it had with instructional materials. "[The teacher leader model] worked in mathematics, but doesn't exist in science," said one principal, while another stated "I don't think the process exists in the district, or at least not in this part of the district." This was likely due to the fact that the teacher leader model for science was only implemented in the deep support networks, in contrast to mathematics, where it was implemented district-wide.

For math in particular, however, some principals noted that in their schools, the teacher leader model was functioning as the district intended. One principal explained, "My teachers go to those trainings. They come back. They share either with their departments or on a whole school professional development day. They have shared those instructional strategies." One principal explained, "I like that format where their colleagues have received training and then they come back and interact with their colleagues and are provided with opportunities to actually go in and observe their colleagues." Still, the success was most prominent in schools that had full-time STEM coaches.

Other principals, regardless of the confidence they had in their teacher leaders, questioned whether they could create the school conditions a successful teacher leader approach required. They pointed out, for example, the lack of time teachers had to enact the intended interactions between teacher leaders and other teachers in the school. One principal specifically noted the challenge that teacher leaders face saying, "well, you can't translate an entire day of learning into a one-hour grade level meeting, where teachers…it's more like a sit and get rather than actually experiencing it…it doesn't transfer the same way." Another concurred, noting, "You sent a teacher to a seven-hour training and yet I only have one-hour grade levels meetings…you got a seven-hour training, I can give you an hour to two hours to teach your colleagues about it, so it just is not a model that I support."

At best, the teacher leader approach was met with mixed reviews. One principal commented on the merits of choosing the right teacher leader: "if you're really strategic in who you send you can have some pretty amazing results in terms of building teacher capacity," while another noted that the loss of the trained teacher leader from the school can mean a loss of that capacity and opportunity for the school as a whole. The different experiences with the model seemed related to other school circumstances, notably financial resources and size. For the schools that didn't have these resources and had to rely on the model as designed – with the teacher leader being a full-time classroom teacher – the benefits of the teacher leader were harder to come by. These criticisms meshed with principals' stated interest in receiving more school-based professional development with the whole school staff. One principal explained that they would much prefer a school-based professional development experience with the whole staff, "not teacher leaders, who are busy full-time teachers themselves, who then have to try and squeeze it in and make time somehow anyway."

Supports and barriers related to the Knowledge Center. The Knowledge Center is an internal CPS website that houses a range of materials and tools that teachers and principals can use to support standards-aligned instruction. There are a number of optional instructional materials and other resources available in the Knowledge Center. For example, MARS Tasks and Math Talks are both instructional resources that are viewed by district central office as very valuable to promote student learning. MARS tasks are formative assessment performance tasks, and Math Talks are ten-minute protocols during which students share multiple solutions for a given problem while the teacher scribes. The Knowledge Center contains other supplemental resources as well, such as Problems of the Month and Formative Assessment Lessons.

"One principal noted, "Math Talks is huge. I would say the majority of observations that I do with entire math blocks, they usually start or end with some form of Math Talk." Notwithstanding the popularity of Math Talks, views on the utility of the Knowledge Center with regard to mathematics were widely varied. At one end of the spectrum, it was viewed as a support for teachers "functioning at the very basic levels in 'struggling' schools." At the opposite end, one principal described the Knowledge Center as their "go-to….one of the great resources." With regard to science, principals mentioned the Knowledge Center less frequently, and those comments focused on the principal using the resources, rather than teachers.

Two principals viewed the Knowledge Center in a more negative light. One principal felt the Knowledge Center was too cumbersome to use, explaining that there are so many demands being made on teachers that it is not a top priority for them to spend time navigating through the Knowledge Center. They explained, "going to the Knowledge Center to sort through some resources is not going to be their number one priority." Another principal reported directing a teacher to other resources because they believed that the materials in the CPS Knowledge Center were not "well-aligned" [to the standards].

Influential factors: district contexts and conditions. Outside of the context of the specific district plan components, a range of additional factors emerged that appeared to have some effect on each school's implementation of and engagement in plan components.

Communication and information sharing. Challenges related to communication from district central office to principals presented themselves in two very different ways. First, on a fundamental, logistical level, some principals didn't know that

professional development was happening or that their teachers were participating. One principal commented, "in the first year and a half or so, [they] had high school PD to which they were directly contacting my science teachers and did not copy me on them so I didn't even know the science teachers were going." Another principal expressed frustration not only about not having sufficient resources for, in this case, science professional development, but also not knowing whether there were district resources available.

Second, principals wanted to better understand the district's vision and, more specifically, what mathematics and science instruction should look like in the classroom. The need for guidance appeared to reside more in the context of science than math, perhaps because the expectations for mathematics were undergirded with clear communication about instructional materials. With regard to science, one principal commented, "the only thing I can remember being really thoughtfully communicated over and over again was the time frame [for the standards effort]." The need for understanding expectations was not only for the teachers' benefit, but it was for the principals' benefit. The extent to which knowledge about the plan components varied across principals may be indicative of the unevenness with which schools engaged with NGSS and CSSS district plan activities.

Each of the twelve principals had a different experience with and understanding of the district's intentions, expectations, activities and supports. The differences were dramatic, ranging from those who appeared to have been deeply connected to the professional development activities to those who were not even aware that their teachers were attending district-provided professional development. Both communication about vision and expectations and communication about daily operations and activities are essential, each supporting the other and each providing foundations on which principals can work with teachers to make progress. Principals wanted guidance not only for their teachers but also for themselves, so that they could engage with and support their teachers appropriately.

District support and human capacity. In addition to the scheduled teacher and principal professional development, principals also had access to supports from district central office and network-based support personnel. Their comments about these supports were consistently positive across principals and across mathematics and science. However, their favorable comments were tempered by the fact that the experiences were so rarely available to them. Principals consistently spoke about their desire for more school-based professional development opportunities that could range from staff presentations to STEM night talks with parents. One principal's interest in more school-based activities stemmed from his perception that the activities run by the district are too "distant from the classroom." Still, this principal realistically acknowledged that more in-school support was cost-prohibitive.

Two principals sympathetically and explicitly commented about what they described as insufficient staffing for the district science office. They expressed clear gratitude for the support they received, which was tempered with acknowledgement about the under-resourced situation. "They're generous with their time. I just think they're strapped and they don't know what to do." One principal suggested that although assistance is available, all schools are not supported equally, with more attention turned to schools that are lower-performing. One principal suggested that those schools that were performing well were not receiving support, and yet wanted it. "I think the district could have done better, and still could do better at supporting all schools. Not assuming if you're level one or one plus school, you're fine. Because we want to stay fine."

Professional development from network Instructional Support Leaders and coaches. In addition to support that may come directly from the district central office, schools have access to support from network-based Instructional Support Leaders (ISLs) and university partner coaches (coaching was only provided in deep support networks). Like support coming from the district level, principals spoke about this support very positively, but also expressed discouragement at the scarcity of such support. One principal referenced network-run curriculum professional development as a support and another said "both the district and network have been very supportive in whatever subject matter we need support under." Another grouped the network support with district support noting that "teachers want to know what [it] is that you want me to teach, and then show me how to teach it…the network and the district has done an excellent job."

The principals spoke about their interest in this support not necessarily in the context of teachers' needs, but rather, because they wanted support for themselves. Or, at least they wanted to be able to rely on the network ISL or coach to provide them with an explanation of what good teaching looks like. One principal imagined, "in a super ideal world, I think you would then also have a network science person who would do demo lessons and have network PLCs around science. I know the networks are pretty strapped right now for funds as well and they've been cutting their people." Another agreed, noting that "having an ISL is wonderful" for the teachers, but the principal wanted more guidance for themselves so that the work the ISL does directly with the teachers and the work the principal does is well-aligned. Some principals noted that there weren't enough ISLs to reach all of the schools in a network who may want or need assistance. For example, one principal explained, "We have no one then to really support us. There is an assigned ISL and he's great but again, he's given to other schools." In another school, an ISL came in and worked closely with a teacher on science; the support was helpful, but then there was no consistent follow-up. Essentially, the ISLs are helpful when they are present, and then their absence is noticed as a "gap in leadership." Other principals expressed the need for tools to help them continue and follow-up on the work the ISLs began in supporting teachers' growth. One principal imagined the kind of interaction they wanted with an ISL, suggesting that the ISL would ideally say, "based on what I know about the teacher, I think we should try this…based on what I see happening, we should try this. We'd come up with a plan and we'd forge forward." However, the principal clarified, "We just haven't had that happen [this year]."

Influential factors: characteristics of individual principals. Some of the clearest influences on implementing the district plans for supporting standards-based instruction that emerged during principal interviews were, of course, qualities of the principals themselves. Earlier, it was noted that principals varied in their background knowledge of mathematics and science, but a range of other principal-related factors, detailed below, also influenced implementation.

Planfulness. Some principals appeared to be more strategic and intentional than others in that they were able to articulate steps for bringing standards-aligned instruction to their schools, including steps that they had already taken and that they had yet to take. These descriptions weren't necessarily written or formal, but they were embedded in the principal's existing leadership activities. For example, one principal spoke about making sure there were funds in the upcoming budget, while another spoke about a systematic process of visiting other schools to learn about how curricula were being implemented.

Willingness to learn. Even as some principals were describing what they viewed as a barrier – their own lack of knowledge about mathematics and science and the standards – they also displayed a supportive disposition, which was their willingness to learn. They expressed an interest in knowing about and using the tools available to them and about gaining deeper understandings of quality instruction and how to support it. This meshes with their demonstrated desire to have more district and network-level support for themselves (and teachers). Providing documents isn't enough; one principal noted "I needed somebody to come in and say 'let me sit side by side, let's do an observation of a math class together and then let's go back and let me coach you how to do a conversation about math afterwards.'"

Willingness to pay. Along with a willingness to learn, some principals also felt able and quite willing to pay for professional development should the district offer it. One principal explained, "I'm happy to fund these opportunities if they're willing to provide some high-level PD that we can send our teachers to." Another principal noted that they could pay for teachers to participate in professional learning communities (PLCs) or designing school-based professional development, but that more guidance from the district would be helpful. One had already moved forward stating, "I made sure, and I'm praying right now, that in the new budget I'll have the funds to do this."

Influential factors: school structures. While some factors influencing implementation of the math and science plans were evidenced in characteristics of individuals, others were more easily seen in organizational (school) structures including school type, size, and human capacity. Although other school characteristics were quite relevant to the schools' engagement with standards-aligned instruction, these characteristics – school type, size and human capacity – were by far the most often raised in the principal interviews. By school type, we are referring to the fact that two of the principals interviewed led a K-8 "STEM school." STEM schools have additional resources to support personnel and STEM-related activities, so this necessarily shaped and informed the principals' answers and point of view about supports and barriers. By size, we are referring to the fact that the principals who participated in interviews led schools of wide-ranging sizes from very small (e.g. one teacher per grade) to very large, with multiple teachers at a grade level or in a department. The school size affects financial resources that the school receives, but more critically, it affects that school's available human capacity to engage with and enact district activities related to standards-based instruction.

For example, in one school, there was only one teacher per grade. In another, a single teacher was teaching all middle grades science. Neither of these situations lends itself well to collaboration, at least not with grade-level peers, which was a suggested routine across the district. Other concerns were practical, with one principal explaining that the teacher leader model hasn't worked well in their school because there is nobody to free up from instruction to attend professional development. Large schools found themselves better positioned to take advantage of the intended professional learning opportunities in that they had enough teachers and administrators to participate without negatively affecting the day-to-day school operations; these larger schools also already had more internal structures for collaborating (e.g. instructional leadership teams).

School size affects the administration as well, with one principal referring to her assistant principal by saying "we divide and conquer." Another principal spoke about how they had no assistant principal so everything fell on them. "Honestly, the year got away from me, I'm not going to lie." The acknowledgement of limited human capacity also affected the plan implementation in that this principal felt that their school "could only take on so much at a time" in terms of where to focus efforts on improving instruction. This principal explained an approach of emphasizing one subject at a time: "my first or second year here is when you focus on one content area, the other two kind of fall by the wayside."

Influential factors: school community. The factors most related to the school community fell into three main groups: those that related to the extent to which standards-aligned instruction was perceived as a shift (i.e., change in practice), those that related to the ways individuals in the school collectively worked (i.e., independently, or in collaboration); and those that related to the dedication of the school staff as a whole to standards-aligned instruction.

Adjusting to the standards. Some principals noted that adjusting to the standards required a significant shift for teachers that, without sufficient attention, could be a barrier to standards-aligned instruction. One characterized the shift to the NGSS as "an uncomfortable transition" for teachers, particularly because at the time of the interview, there hadn't been the same amount of district professional development devoted to NGSS as there has been for CCSS. Another instituted a strategy to introduce the NGSS gradually, so as not to overwhelm teachers. In this strategy, teachers would identify places in their current instruction where they were already enacting the standards. Another principal mentioned that the NGSS were a shift particularly for teachers who were accustomed to teaching "content" rather than teaching "skills," and also noted that the NGSS required teachers to make shifts in the language they were expected to use (e.g. "learning objective"). This transition was particularly salient for the NGSS because there have been fewer and less clear directions and supports from the district regarding instructional expectations.

As with decisions about which science instructional materials to use, in discussions about how best to help teachers adjust to the standards, principals again felt "left on their own." This is not surprising since the two are closely related. One might expect that teachers may feel more comfortable making the transition if they have clear and supportive instructional resources to assist with that transition. One principal observed that teachers are being asked to implement complex instruction without the answers to "very simple, basic questions" such as what a curriculum map might look like. Another noted that it was critical to have "a clear scope and sequence that is suggested or at least mapped out halfway intelligently…" There was a sense among principals that teachers were left to figure out how to align their instructional practices to the standards while simultaneously considering ways to use previous materials or units and align their content with the standards.

Related to the adjustments to the standards and the need for materials is the extent to which principals and teachers have the time to learn and consider standards-aligned instruction themselves. Some principals revealed that they had personally spent time engaged with the content of the standards. These principals described working through the "look-fors" (i.e., indicators of standards-aligned instruction) or participating in additional professional development. For example, one principal attended a professional development experience that provided opportunities that had "really supported their thinking around the TRU Math [Framework], the rubric and thinking about that deep conceptual understanding of math."

Collaboration. Overall, principals seemed in favor of increased teacher collaboration, but they expressed considerable concerns about finding time to collaborate. In smaller schools, for example, the barriers are easily seen and more difficult to address because in these schools, there are simply not enough teachers at a grade level to collaborate. As one principal noted, "If they want something at their grade level, they have to seek it out themselves." Some of the circumstances that challenge the full enactment of the teacher leader model present themselves as barriers to in-school collaboration. Still, principals of larger schools described that their teachers engaged in different ways of collaborating, including department-specific professional development and within other professional development structures. Collaboration was not limited to interactions within schools. In describing the ways they sought out solutions, principals described working with other schools or reaching out to other schools in search of successful strategies that others had used. One specifically described a positive experience of teachers engaging with others outside the school during the process of curriculum selection, viewing it as an opportunity for collaboration among teachers across schools as well as within the school.

Teacher dedication. A third emergent factor pointed to the work of individual teachers within the schools, rather than collaborations among them. Some principals spoke about the dedication of their teachers as an essential part of their schools' abilities to move toward standards-aligned instruction. For example, one principal spoke about teachers doing professional development at night because they were "trying to get on top of this" with little support. Another described the fact that a teacher was taking steps to move the science program forward without being asked to and in doing so, got everybody interested and "on board."

SIGNIFICANCE

In order to move forward with standards-aligned instruction, it is essential to understand practitioners' experiences from their perspectives. First-person accounts of large, district initiatives from participants "on the ground" can identify particular circumstances in which designed activities are or are not having the desired effects; they can also provide essential information for informing a process of ongoing initiative improvement. In the present study, we have identified key supports and barriers to schools' engagement with the district math and science plan components as articulated by twelve CPS principals working across a wide range of circumstances.

Although a few common themes emerged from these interviews, we acknowledge that we cannot generalize our findings from this small, non-representative sample to the schools in CPS as a whole, nor to schools in general striving to improve teachers' math and science instructional practices. At the same time, some of the observations these principals collectively made about their successes and challenges are noteworthy because they highlight pervasive issues that have been uncovered time and again in the education research literature

– observations such as, "teachers need more time to collaborate" (Wenner & Campbell 2017); "curriculum materials are important for guiding instruction" (Ball & Cohen, 1996); "resources for science instruction are given short shrift at the elementary level" (Spillane et al., 2001); and finally, "there are not enough resources (human or financial) to meet professional development needs for all" (McLaughlin et al., 2014). These holistic observations, articulated as barriers to enacting district reforms by our twelve principals, are quite often simply considered as "givens" in the world of education: phenomena that as a field, we all generally understand to be true.

At the same time, principal interviews revealed that their individual experiences were in no way uniform. Some schools' needs were met, and others were not, with respect to multiple aspects of the district math and science plans. While some principals felt they had sufficient professional learning opportunities for themselves and for their teachers, others did not. Some principals felt their teachers had access to and proficiency with aligned instructional resources for math and/or science, but others did not. Some principals were satisfied with the amount of in-person district support for math and/or science instruction, while others needed more. Some schools had an easier time in their ability to engage in the teacher leader model as intended, while others had a more difficult time. The presence and extent of influential factors uncovered in these interviews (differences related to principal characteristics, school structures, school community) accounted for some of these differences. Factors related to each principal's local circumstances interacted with district factors (in particular, human resource limitations and associated levels of communication and support) to produce twelve unique stories amid the commonalities we have identified above.

Making the conclusion that all schools operate under different contexts and conditions, and therefore have more or less successful experiences with enacting standards-based reforms, may seem obvious. However, we believe it is time to give this variability the serious consideration it is due. Rather than merely acknowledging the realities of "school variation" and the pervasive challenges that are present across standards reform initiatives, our charge as educational researchers and practitioners is to ask ourselves how we can apply this knowledge to better design our reform initiatives, anticipating these challenges at the outset and being more intentional about re-allocating limited resources to develop customized approaches. Given that we know that schools will experience singular initiatives unevenly, for example, it seems prudent to design the district-wide initiatives with adaptability and nimbleness. As a field, we regard differentiated instruction as fundamental to student learning; we must apply this same value of differentiation to our reform efforts for teachers and principals. Perhaps in the future, researchers and practitioners may work together in collaboration to develop a menu of options that may be enacted in different combinations, rather than create a design that, due to the wide variation in schools, is unlikely to work well for all. We hypothesize that if the field comes together to engage in this difficult work, we will be able to find ways that ensure each school a solution with the best fit that, in turn, helps them achieve more consistent outcomes.

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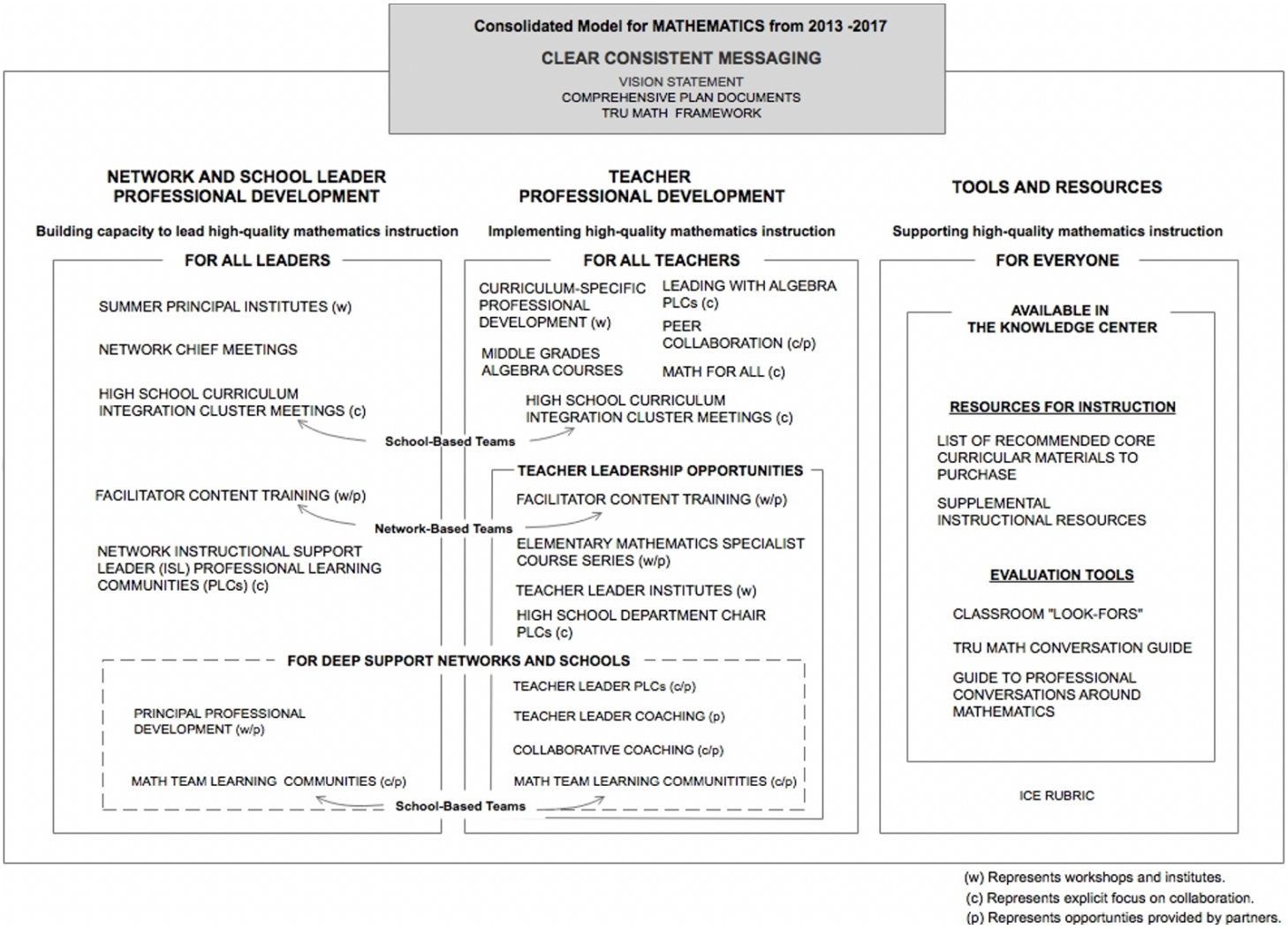

FIGURE 1.

CPS Plan for Achieving the Common Core State Standards for Mathematics (CCSS-M)

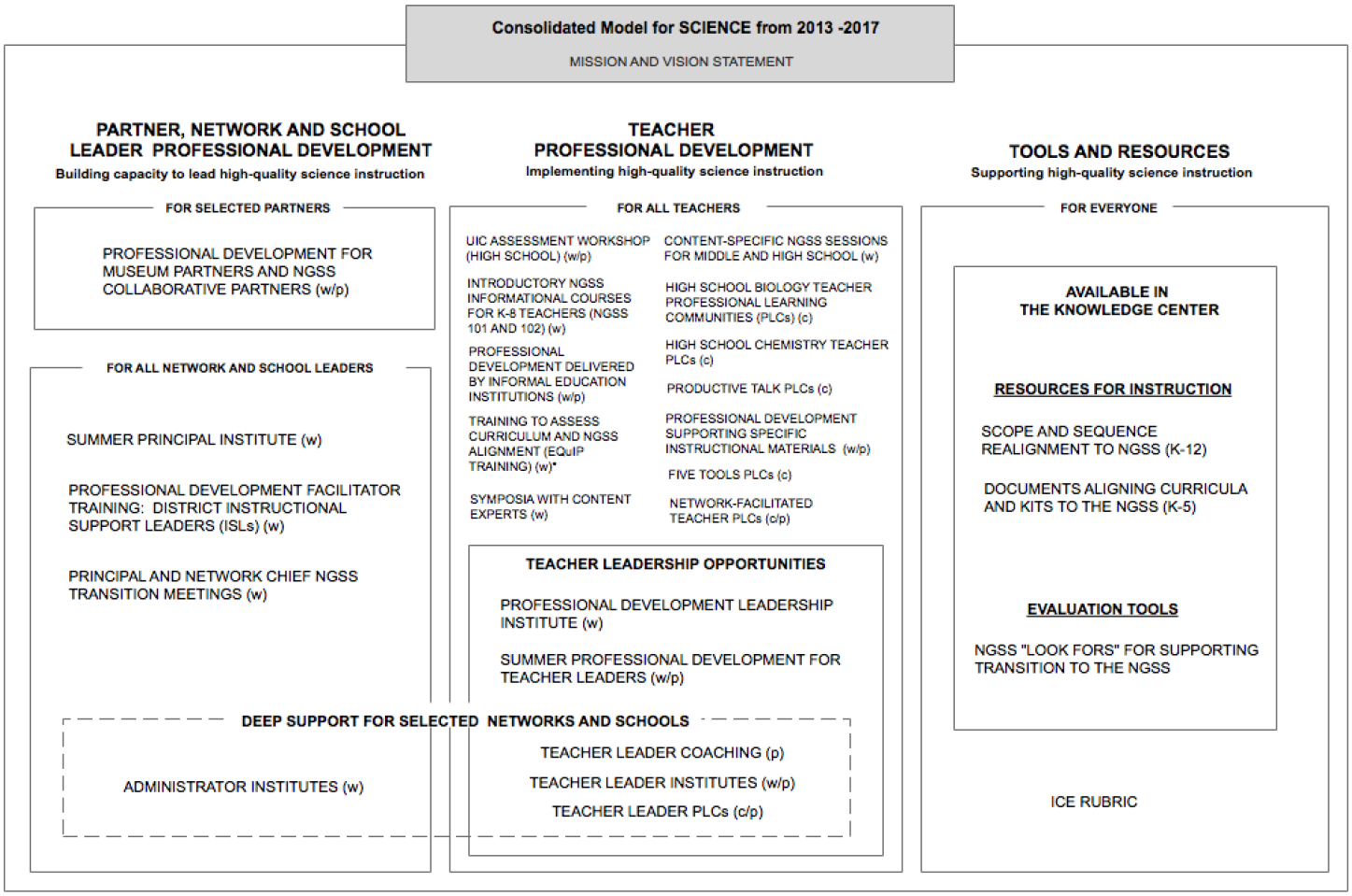

FIGURE 2.

CPS Plan for Achieving the Next Generation Science Standards (NGSS)