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To cite this article: Rossella Santagata, Jiwon Lee, Jody Guarino & John Drake (2023): Centring Teacher Voices in School-Wide Improvement: Possibilities and Challenges of Introducing Change in Complex Systems, Professional Development in Education, DOI: [10.1080/19415257.2023.2229344](https://doi.org/10.1080/19415257.2023.2229344)

To link to this article: <https://doi.org/10.1080/19415257.2023.2229344>



Published online: 02 Jul 2023.



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Centring Teacher Voices in School-Wide Improvement: Possibilities and Challenges of Introducing Change in Complex Systems

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ABSTRACT

This study aims to unveil the complexity of introducing and sustaining instructional improvement at a school site by documenting successes and challenges encountered by a research-practice partnership among university researchers, school and district leaders, and a mathematics coordinator from the county office of education. The study answers two questions: How did a research-practice partnership attend to teachers' voices and craft coherence around a school's mathematics teaching improvement goals? What characterised the complexity of sustaining the improvement efforts? Data included meeting fieldnotes, teacher survey responses, and transcripts of interviews with teachers, school and district leaders, and the county coordinator. Qualitative thematic analyses revealed several ways in which the team attended to teacher voices and crafted coherence dynamically through interactions supported by tools and activities aimed at surfacing complexity and creating a shared vision. Points of convergence included a focus on adult learning and collaboration. Analyses also unveiled challenges, including the emotional work entailed in instructional change and the necessity to buffer the school from conflicting external demands. Conclusions highlight the importance of deliberate negotiation of tensions and crafting of coherence so that stakeholders can more easily build a shared vision for high-quality classroom teaching and high-quality teacher learning.

ARTICLE HISTORY

Received 6 March 2023
Accepted 20 June 2023

KEYWORDS

research-practice partnerships; mathematics teacher learning; school; district; system

Introduction

This study examines the work of a US-based research-practice partnership (Farrell *et al.* 2021) between a school district, a county department of education, and a university that engaged in the design of teacher professional development (PD) at a school site to improve elementary school children's opportunities to learn mathematics. The partnership improvement efforts built on the strides that have been made in the understanding of experiences that are effective at supporting instructional change (Sztajn *et al.* 2017). As suggested by the PD literature, partners moved beyond the consensus of *features* that characterise high-quality PD, to design teacher learning settings intended to promote particular *learning processes* that have been shown to lead to change (Givvin and Santagata 2011, Santagata and Bray 2015). In addition, they integrated multiple strategies to unveil and respond to teachers' priorities, drawing on research that indicates that if teachers' needs are not considered, poor engagement and limited impact might follow (Kennedy 2016). Attending

directly to tensions as they emerge and adapting PD to address them can be productive when stakeholders recognise the necessity to negotiate visions and goals to move the work forward (Johnson *et al.* 2016).

The partnership work was also characterised by a systemic vision of teacher learning: A vision that centres coherence across the various levels of the institution and its actors (i.e. classroom teachers, school leaders, and district leaders) and recognises as essential the goal of improving alignment between PD and curriculum, assessments, and district priorities (Cobb *et al.* 2018). Centred at the intersection of literature on teacher learning and on schools and districts as learning organisations, this study aims to unveil the complexity of introducing and sustaining instructional improvement – with teachers’ needs and priorities in mind – by documenting the work of the partnership, its successes and challenges.

Teacher learning within complex systems

A situative theory of teacher learning informed the partnership improvement efforts. According to this perspective, teacher learning is defined as change in participation in socially organised practice (Putnam and Borko 2000). Participation involves ‘orchestration of understanding, skill, relationship, and identity to accomplish particular activities with others in specific environments’ (Grossman *et al.* 2009, p. 2059). In this sense, teacher learning is much more than acquisition of new knowledge. It requires shifts in vision, practices, and identity as teachers participate and interact with others in specific socio-cultural and institutional contexts (Herrenkohl and Mertl 2010). This vision of teacher learning also calls for researchers to understand teachers as actors in a complex system and their learning as a process that entails navigating multiple pressures and demands through interactions with peers and school and district leaders.

Research on district-school relationships rejects the idea that teachers can simply close their classroom doors and escape from pressures and demands from district central offices. Through their educational infrastructure, including curriculum materials, student assessments, and organisational norms and routines, district offices influence teacher interactions and their classroom practices (Spillane *et al.* 2018). At the same time, teachers mediate these influences through their values, beliefs, and practices that are informed by their prior interactions with district leadership (Coburn 2004). In other words, the influence of district offices on teachers and school practices needs to be understood in its dynamic nature, not as static and unidirectional, rather as constantly negotiated through ongoing interactions.

Prior research also suggests that PD design needs to take into account the multitude of initiatives that often characterise district and school functioning and detract teachers’ attention, often carrying with them divergent values and visions for high-quality teaching and learning (Munter 2014).

A recent systematic review of studies on coherence in K-12 teacher PD (Lindvall and Ryve 2019), identified 95 papers on the topic and highlighted the variety of ways in which coherence is conceived, with most studies focusing on coherence between PD and external factors and assuming coherence as a need for objective alignment and uniformity that is possible, desired, and important to establish at the onset of PD. Most studies also position teachers as implementers or enactors of predetermined practices with limited opportunities to exercise their professional judgement. Instead, ‘the positioning of the teacher as a negotiator in the context of PD is barely visible’ (Lindvall and Ryve 2019, p. 151). Only five studies conceived of coherence as a craft and its negotiation as integral to the goals of PD efforts. We thus aim to contribute to this scarce literature and illuminate teachers’ role in meaning making (Remillard 2005) and in adapting PD offering to their local context (Koellner and Jacobs, 2015).

Additional important considerations in the design of PD are around the role that school and district leaders should take to support teacher learning. School leaders may shape the interactions teachers have with district initiatives and other external demands. Honig and Hatch (2004) describe ‘bridging’ and ‘buffering’ activities that schools can engage in to either invite or increase

interactions or to limit them. For example, school leaders might participate in a state program that provides resources to advance their school goals or they might invite university researchers into their schools who can help them monitor the success of a particular program while offering additional resources to support teacher learning. On the other hand, school leaders might protect their staff from policies and programs that are not aligned with their improvement focus, thus buffering the school from external pressures.

Research on the relationship between the institutional environment and the classroom suggests that district leaders can also play an important role. District leaders are well positioned to either support or hinder school level improvement efforts by engaging with school leaders and teachers and promoting particular conceptions of the nature of teaching and learning that contribute or challenge coherence of improvement efforts (Bidwell 2001). The literature on district influences also highlights how district leaders' norms and conceptions are constructed through social interactions over time and are responsive to policy and governance structures (Coburn 2004). In addition, district central offices should not be thought of in monolithic terms. Often multiple, and sometimes contrasting, visions of high-quality teaching and learning co-exist among district leaders, creating complex systems that teachers and school leaders need to navigate (Munter and Wilhelm 2021).

It is within this complex dynamic that this study examines one school's efforts to develop a shared vision of mathematics teaching and learning and a stable system of productive settings for supporting instructional improvement. Findings support the notion put forth by Honig and Hatch (2004) that coherence is 'an ongoing process involving multiple actors both internal and external to formal school systems' (p.17); as requiring 'school and school district central office leaders to work in partnership to continually "craft" or negotiate the fit between external demands and schools' own goals and strategies' (p.17); and as 'a social construction produced through continual interactions among teachers, students, organisational structures, curriculum, and other tools of schooling.' (p.18).

While the notion that crafting coherence is an ongoing process has been integrated in the work of several scholars who study school and district leadership (e.g. Gamoran 2005, Timperley and Parr 2007), still missing are accounts of what the process of crafting coherence looks like in practice and concrete examples of how complexity is experienced by the various stakeholders involved in instructional improvement (Lindvall and Ryve 2019). In an effort to provide such contribution, this study centred on the following questions:

- (1) How did a research-practice partnership attend to teachers' voices and craft coherence around a school's mathematics teaching improvement goals?
- (2) What characterised the complexity of sustaining the improvement efforts?

Methods

Participants

The study involved a partnership between two researchers working at a public university in the United States, the mathematics coordinator of the county department of education, and the leader of primary education of a school district serving approximately 20,000 students. The partnership efforts focused on improving the mathematics learning opportunities and outcomes of students enrolled in one of the district elementary schools, whose principal joined the partnership and the improvement leadership team. The elementary school enrolled approximately 400 predominantly Latinx students (96%), of whom approximately 70% were English Language learners and 85% from socioeconomic disadvantaged backgrounds. According to state standardised testing data, the year prior the start of the project, approximately 28% of the grades 3 through 6 students met or exceeded their grade level standards. The principal described the families served by the school as committed

to their children's education and highly engaged in school community activities. Partners began to collaborate in August 2019 in an effort to support mathematics professional development for the school's 17 teachers.

Settings for improvement

Building on the literature summarised above that recognises the complexity of educational systems, settings for improvement were structured to bring stakeholders together to learn and reflect on their learning and to create multiple opportunities for negotiating priorities and needs, and for crafting coherence together. The improvement leadership team met regularly (bi-monthly or weekly) throughout the duration of the project in 2019–20 and 2020–21, transitioning their in-person meetings online in March 2020 when the school closed because of the COVID-19 pandemic and implemented a first period of distance learning, followed by hybrid instruction during which children attended school for approximately half of the school day and completed the day online through asynchronous activities.

Teacher professional development was structured around defined and clear goals that included the development of teacher content knowledge, pedagogical knowledge, and knowledge of student mathematical thinking; teacher beliefs and professional vision centred on student thinking and responsive instruction; and teacher dispositions and skills for self-reflection and learning from teaching (Carpenter *et al.* 1999). PD grounded in teaching practice allows different stakeholders to navigate, negotiate, and resolve tensions (Kazemi and Hubbard 2008; Sztajn *et al.*, 2014); thus, we centred joint work between teachers and the PD facilitator (i.e. the mathematics coordinator) around artefacts of teaching, such as student work, lesson planning protocols, mathematics manipulatives, and video clips of teaching interactions. Teacher learning was structured into four settings (summarised in Figure 1 below), each supported by the expertise of the mathematics coordinator. The four settings were tightly coordinated, and the school principal exercised a significant role in developing and maintaining this system of support (Clement and Vandenberghe 2001, Stevenson *et al.* 2016, Liu and Hallinger 2018, Hallinger and Kulophas 2020). He attended all professional development meetings, engaging in activities as a learner alongside his teachers, co-facilitated staff meetings and teacher collaboration, participated in *Math Labs* (guided lesson observations and debriefing with classroom teacher; Gibbons *et al.* 2017), and engaged in co-planning and co-teaching with his staff. Planned professional learning settings had to be interrupted or modified in March 2020 due to school closure and distance learning, but teachers continued to meet online for their staff meetings and grade level teams continued to meet online to plan for math instruction (Guarino *et al.* 2020).

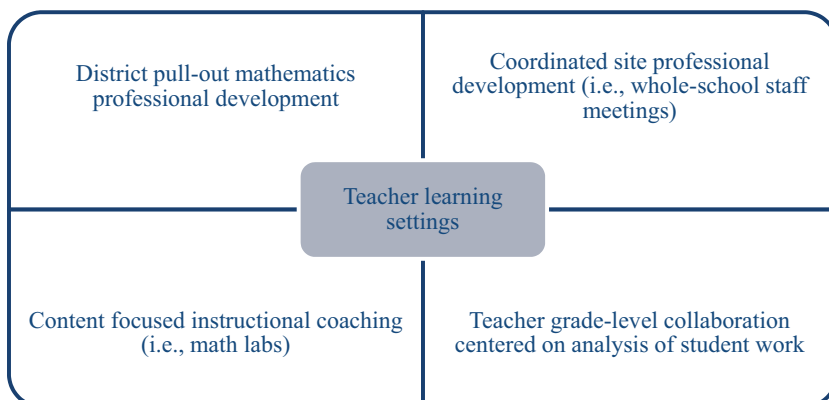


Figure 1. Teacher learning settings.

Through the research-practice partnership arrangement, university researchers served as mirrors (a term used by the school leader to describe their function) and as a sounding board. They provided critical reflections, shared existing research evidence relevant to mathematics teaching improvement, developed tools to monitor improvement and challenges, and contributed to building capacity at the school and district levels. Specifically, researchers collected field notes to document decision making processes, conducted ongoing observations of PD meetings and classroom instruction, administered teacher surveys and interviews, assisted with student interviews and analysis of student work, and interviewed the leadership team. At the end of each year, researchers also wrote yearly reports summarising the partnership activities, outcomes, and lessons learned with specific advice for moving the efforts forward.

Data sources and analysis

Data collection occurred throughout the two years of the partnership. Researchers collected detailed field notes of improvement leadership team meetings and created annotated memos summarising meeting main topics, design tensions that emerged, questions that were raised, and artefacts that were created as the product of joint work and conversations.

Teacher surveys included both closed and open-ended items and a combination of questions adapted from existing instruments and developed by the research team. Questions documented teacher math learning and teaching beliefs (Carpenter *et al.* 1989), vision of high-quality math instruction (Munter 2014; *If you were to walk into another teacher's classroom, what would you look for to decide whether the mathematics instruction is high quality? (Please identify specific qualities or features and provide your reason why it is important to see that in a math classroom)*), perceptions of learning from PD and staff meetings (e.g. *Has your mathematics instruction changed as a result of participating in the Wednesday staff meetings this year? If yes, in what ways? If not, why not?*), and vision of high-quality collaboration (e.g. *If you were to walk into a school where teachers collaborate on their math teaching, what would you look for to decide whether their collaboration is productive?*). Surveys were conducted at the end of each year. For the purposes of this study, analyses focused on survey questions that provided insights into teacher experiences with the school improvement efforts in both formal PD settings and informal collaboration with colleagues and school and district leaders. Surveys were complemented by semi-structured interviews, also administered at the end of each year, that asked teachers to elaborate on survey responses and describe in their own words the successes and challenges they experienced. Finally, the improvement leadership team was interviewed by a researcher external to the partnership. Interview questions focused on team members' experiences within the partnership, their perceptions of collaborative work, how they benefited from working together, and what tensions and challenges they experienced.

Teacher survey responses and summaries of interview responses were organised into an Excel spreadsheet by questions that targeted similar topics to allow for easier analysis of experiences for each teacher. Teacher interviews included rich data for the purposes of this study, therefore the MAXQDA qualitative data software was used to code interviews thematically. Through iterative coding (Strauss and Corbin 1990, Miles and Huberman 1994), initial codes were descriptive and categorised participants' responses focusing on vision of school improvement; types of successes teachers experienced; common challenges; and type of support they found useful.

Improvement leadership team interviews were also analysed thematically and descriptive categories were created focusing on teacher voice and needs; collaboration; school and districts as learning organisations; and system complexity.

Descriptive categories from the survey responses and two sets of interviews were then grouped into larger categories through the constant comparative method to create themes at a higher level of abstraction (Strauss and Corbin 1990). These are described in the findings below.

Findings

Surfacing complexity and crafting coherence

Analyses of fieldnotes and artefacts produced by the improvement leadership team revealed several ways in which the team attended to teacher voice, unveiled the complexity of engaging in improvement, and crafted coherence dynamically. The team spent the first five meetings to identify goals for the improvement efforts and ways to measure progress to collect evidence of student learning, while also making student progress visible to teachers to keep them motivated to try new practices in their classrooms. The team's negotiated vision for improvement was embodied in several artefacts, including goal setting charts, action plans, and co-authored presentations to various audiences, both in university settings (i.e. presentations to a research centre colloquium series and in a course for pre-service teachers) and district settings (i.e. a presentation to the district cabinet). Artefacts are too many to share in this short publication. Here we include two conjecture maps (Sandoval 2014) that were created at the beginning of the first year of the partnership and at the beginning of the second year (Figures 2 and 3).

The process of conjecture mapping, borrowed from design-based implementation research (Penuel *et al.* 2011), can be conceived as a process of surfacing complexity and crafting coherence. Building on observations of PD meetings and classroom observations and on several conversations with team members, including brainstorming and charting activities, researchers created the map, shared it with the practice partners and revised it to represent the team's shared understanding at a particular moment in time. Partners negotiated outcomes and a vision for the improvement work are represented in the principled ideas included in the high-level conjecture. The embodiment part of the map represents the activity structures, tools and materials and discursive structures through which partners aimed to realise the conjecture. The mediating processes illustrate the planned enactment of improvement efforts. The differences between the first and second year map illustrate the team's evolving conceptions as informed by a year of improvement efforts and deliberate collection and analysis of both teacher and student learning artefacts.

During the first year of the project, the team decided to monitor student learning from the lower grade students whose teachers had completed the first year six days of pull-out PD before the COVID-19 pandemic led to school closure. This decision was driven by multiple goals, including

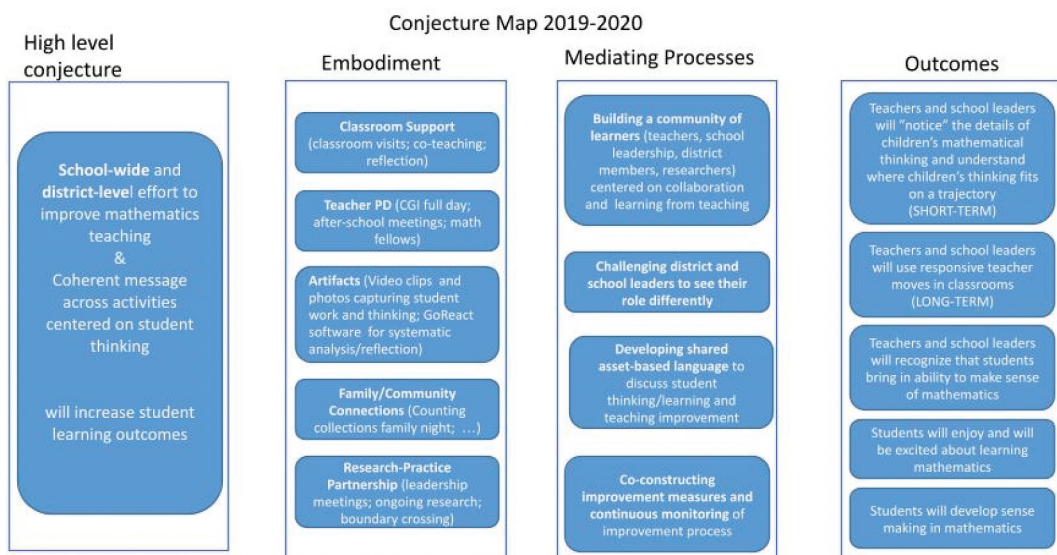


Figure 2. Conjecture map for 2019–2020 school year.

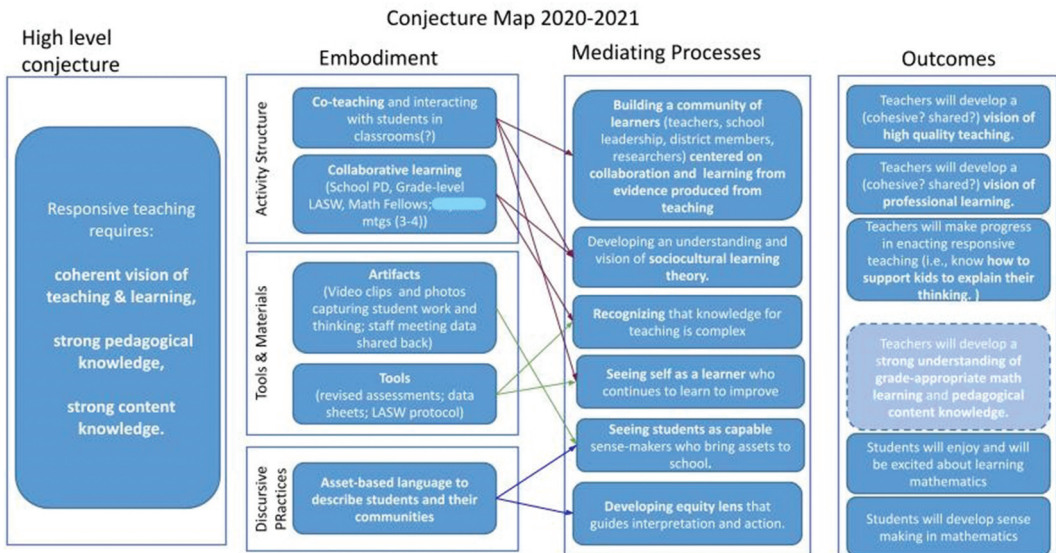


Figure 3. Conjecture map for 2020–2021 school year.

collecting data that would test our PD model, sharing with teachers their students' progress, and communicating with the district central office about the successes of the improvement efforts. To achieve this goal, the team agreed on a few open-ended mathematics tasks aligned with the PD content and approach to math teaching that administered as pre/post tests would capture student evolving sense making. Of importance is to note the role that the district leader played in this decision, by allowing teachers and the school leader to substitute this newly developed assessment from a district-mandated assessment built on a different vision of mathematics learning.

Attending to teachers' voices

Improvement team meeting fieldnotes and artefacts from the PD and staff meetings document several questions the team discussed related to attending to teachers' needs and priorities and the resulting strategies that were employed to integrate teachers' voices in the design of PD and staff meeting activities. Across several meetings the team discussed whether and how to involve teachers as partners in the improvement efforts and in planning staff meetings; how to invite teachers to participate in the research study while respecting their professional priorities; how to elicit teachers' questions and wonderings and how to integrate them into the goals and embodiment of the staff learning activities; and how to select teachers to take on leadership roles and define the directions of the improvement efforts within the constraints of the district and union requirements for additional work and pay. Meeting after meeting, the team reviewed post-it notes from staff meetings where teachers expressed their wonderings and field notes that documented aspects of the planned activities that were successful and those that needed improvement. These conversations highlight the complexity of the many decisions that school and district leaders and PD facilitators take, the relational nature of these decisions, and the dynamic process that shapes how improvement efforts are ultimately enacted.

Two artefacts from one of the improvement leadership team meetings (see Figures 4 and 5) illustrate the type of conversations that team members engaged in. The charting of assets that teachers brought to the staff meetings, and as evidenced more broadly in their teaching and conversations, were complemented by charting of challenges that were observed. This explicit

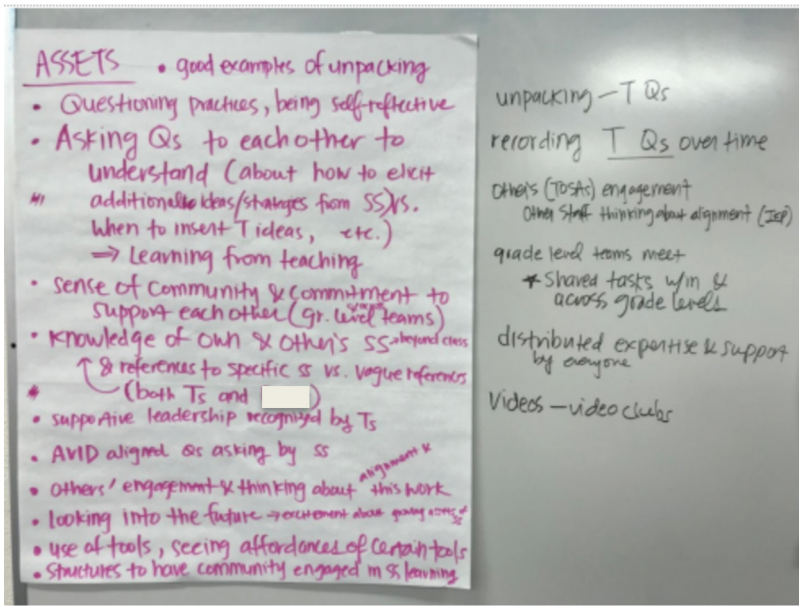


Figure 4. Chart of teacher assets observed by the improvement leadership team.

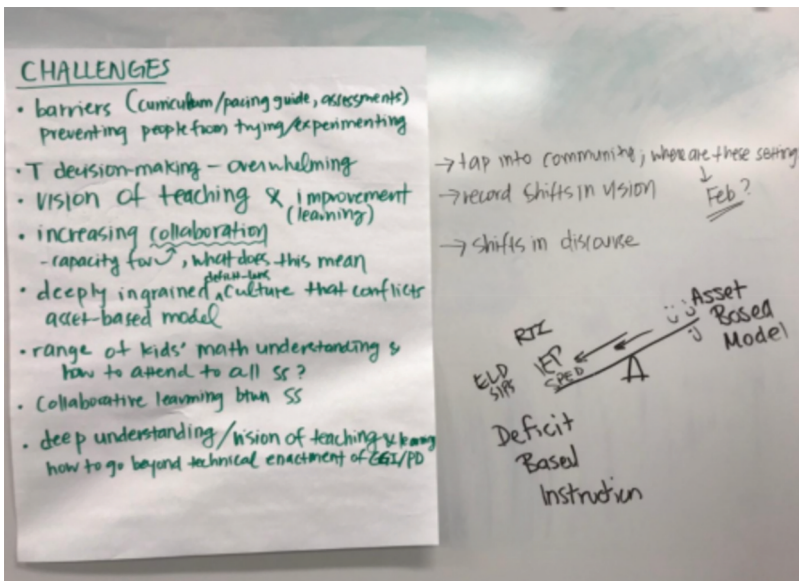


Figure 5. Chart of remaining challenges observed by the improvement leadership team.

attention to challenges was intentionally designed to keep complexity to the forefront rather than settling in on a general sense of satisfaction with progress the team observed. The team also started to brainstorm ideas for supporting teacher learning and for documenting that learning as indicated by the writing on the board to the right of the charting paper. This process allowed the team to craft a path forward while documenting evidence of successes and remaining needs that considered together helped in planning for the next steps of the continuous improvement efforts.

The negotiation of possible alternative paths forward during each meeting was ultimately settled through the creation of google slides to use at the staff meetings that guided the co-facilitation of teacher learning activities by the school leader and the math coordinator. Plans often included specific roles other team members could play, including supporting teacher learning by joining particular table groups of teachers at the staff meeting and attending to their participation.

To address the need to increase collaboration among teachers, a tool for joint analysis of student work and lesson planning was adapted from prior research (Bray *et al.* 2019). This artefact was piloted and revised to be able to respond to the time constraints that teachers expressed, limiting this activity to 30 minutes a week. The protocol supported an efficient and productive use of that time and resulted in collaboration that several teachers described as highly productive and fundamental to their learning and instructional change. Thus, the team was able to devise a solution that supported teacher learning within the parameters for time allocated to teacher collaboration set up by school and district policies.

Converging on a vision for adult learning and collaboration

Fieldnotes, survey and interview analyses highlighted two themes around which the partnership was able to craft coherence: a focus on adult and institutional learning and collaboration as a vehicle for joint work on improvement.

Adult and institutional learning

As one might expect, different stakeholders noticed and reflected on experiences closer to them and on learning as it pertained to their professional role. Ms. M., an upper grade teacher, commented on how both her principal and the district administrator engaged in learning together about mathematics teaching:

I like it. And at first, you know, it kind of seemed like, wow, this is really intimidating. They're gonna be sitting and listening to my ideas . . . But they really have made a great effort and being vulnerable themselves and just saying, like, we don't have the answers, and we're in this learning together and that kind of thing has helped a lot. I mean, I think it takes a certain administrator to be able to sit back and be a learner along with the teacher rather than just let me, 'please tell me what you did.' So, I'm appreciative of collaborating with them.

The school leader reflected on the opportunities for learning and building his capacity that the meetings with the improvement leadership team provided for him:

We just talk, we talk about professional development and we talk about systems. We talk about processes, we talk about their [the researchers'] data, books. So, I think because of my interaction with them [the improvement leadership team], it's changed that whole professional aspect of my life. And it's really built my capacity. And it's made me realize that I want my teachers to have this opportunity to have these professional dialogue about articles, for example, research. Because it's so important. Yeah. So now I'm having this huge benefit. And I want my colleagues to have that too.

Similarly, the math coordinator commented on the benefits for her as a professional to engage with research partners. Research allowed her to have evidence of her impact at a grain size not possible were her to consider her effectiveness on her own:

An opportunity to have thought partners . . . And to be more intentional really appealed to me again . . . this is what I do for a living and I feel like I might be successful, but I actually don't know. I don't know if anybody's taking anything . . . Where this would actually give me insight into –how are people taking it up? And I feel like I have learned so much through this partnership that it makes me rethink everything that I've been doing and the grain size of which I understand what I'm doing is so completely different.

Finally, the district leader recognised the importance for the district as a whole to engage in learning while highlighting the challenges of doing so:

There's a need for us as a district to focus on learning. I know that sounds really weird, coming from a school district, but we do have a tendency to get caught up in the, I guess the politics and the... I don't even know how to say it, but worshipping what maybe looks good, as opposed to really understanding whether or not kids are learning. And so, I think a big next step for us as an entire district is to do some work around, and some learning around, learning together around learning, if that makes sense.

This collective learning was an ongoing process that required continuous negotiations across different levels of the system. At each level, teachers, school and district leaders, and the math coordinator strived to be responsive to the learning needs of others and to respect their professional judgement. Mr. R, an upper grade teacher, discussed his vision of mathematics teaching at the school site:

Our math instruction is student driven... we're responsive to what the students need, as opposed to feeding the students something that is scripted without paying attention to what their understanding or their needs are.

Ms. A., a lower grade teacher, discussed what being responsive meant in her classroom and how her observations of student progress drove her instructional decisions while also providing opportunities for her to learn from her students:

I've never really, like been super, super intentional about each math lesson, like every day has been so intentional because it's based on the previous day, or I'm actually diving in and getting something from their work. Most of the times I was assessing... district mandated assessments. And I wasn't—the data I was getting from that wasn't truly telling me anything. And I felt like I had to move on anyways, even though I would see a gap in learning. And so that's really like, for me, just, it's really impacted the way that I've not only been teaching but what I've been learning from my students...

While teachers discussed how they were responsive to their students, the district administrator described how the school leader demonstrated responsiveness towards his staff:

I want my principals to be like Dr. D in that, you know, he's constantly focused on—you know, their goal, but assessing where his staff is in relation to making progress towards that goal before he decides what he's going to do next with them.

And the school leader himself discussed his attentiveness to his staff's readiness for change. The school and district leaders took on roles previously described in the literature. As Honig and Hatch (2004) discussed, school leaders serve as 'grounded interpreters of their multiple demands and school district central office administrators become interpreters and supporters' (p.19).

'Yes, that's a great idea, you all,' but I'm the one that needs to be thoughtful about where my faculty is in regard to readiness. Do I put on the brakes or put on the gas, it's not about whether or not your idea is right or good, it's about: is this too much right now?

In his role, the school leader made decisions for steps forward by considering what his teachers were ready to take on, what the data the research partners provided suggested, and what the opinion of the math coordinator – his coach and 'knowledgeable other'—was.

They [the researchers]'re a mirror, they're often providing written summaries of all the meetings that we have, and sometimes I read them and recognize, oh, wow I didn't really think about, I didn't see that happening, but they caught it... The data reflects that lack of knowledge and that is powerful. If we hadn't had [the researchers] bringing us these data we just wouldn't know the impact of this lack of training. I wouldn't. Because of these data, I clearly know now what are next steps, and had I not received those data, I don't think I would. Our next steps would not be so clear. After the entire team looked at preliminary data, [the math coordinator], the knowledgeable other, my coach, and I spent time discussing next steps and how this best informs our work with teachers throughout the 2020–2021. Because of this work, at the school site and perhaps, over time, at the district level, we will become more of a learning organization where research does support change.

Collective learning as an ongoing and complex process was evident in the district leader's reflections on the tensions that often districts experience between wanting to learn and needing to produce, processes that are odd when it comes to the time needed to introduce and sustain change:

I think that part of the tension from a district perspective is we just want to go and get it done right. There isn't a place right now, so there's a tension of being in that place of a learner, but being asked to produce. If that makes sense. That I think comes out of my office more than I'd like it to. You know, there's a tension of really, I think, for me anyways, of priorities. I would say if we were to do kind of an audit of what comes out of my division, very little of it is focused on learning and a lot of it is focused on doing.

Collaboration

Collaboration to foster learning was a key component of the project design as illustrated by the conjecture maps. The quotes above already highlight how collaboration among different stakeholders was a vehicle for learning and improvement. Collaboration among teachers was discussed in detail in teacher survey responses and interviews and by the school leader and math coordinator in their interviews. Collaboration provided both a system of support for teachers to learn together and a way to foster teacher autonomy and sustain change over time in the eyes of the school leader.

A lower grade teacher, Ms. A, described how collaborative planning with her grade level team created a supportive space for her to focus on improving her teaching and overcoming the frustrations that come with learning something new:

Is just being able to talk through the experiences that we've had in our individual classrooms. Because, for instance, my class is really strong with adding but for another class, it would, they're really strong at subtracting. So just being able to look at the various skills that our students bring, and then come together with a common goal and a common focus, and all do the same work. So, we're all doing the same word problems. And most of the time too it's like, oh, I'm glad I'm not the only one having this issue or stressing over the fact that they're not quite using a certain strategy. So just having a support group really, just there to not only help me focus on each day, but knowing too that I can count on them to get me through the frustration sometimes, you know, we're all new to this.

The school leader discussed collaboration as a primary lever to introduce and sustain change.

I'm beginning to recognize the collaborative time as the most important piece in regard to initial change and longevity of this approach to teaching and learning. Because you're building, through those regular conversations, you're building the capacity and the knowledge of teachers. You're moving them to a place where they're reliant on one another and less reliant on this training that they had. In two to three years, the teachers have long completed the training—there has to be a system in place for them to continue their learning. Right? In addition, this type of collaborative environment begins to provide, and ideally moves teachers, to have more autonomy over their teaching and learning.

Teacher collaboration was also discussed by the math coordinator as a space for teachers to celebrate success both in students' and in their own learning:

One of the things that's started to come up a lot within those two grade levels also is the teachers will say things like, wow, I'm seeing things I've never seen kids do before. And then they'll say, maybe they did it before and I didn't actually notice or I didn't know how to make sense of that. And they say things like, I didn't even know this thing was possible that my kids are doing. And there's also a lot of like, I wonder, the kids are learning a lot, but I think I'm learning a lot, like I'm a different person.

The focus on learning and collaboration supported partnership stakeholders in navigating complexity and led to some positive outcomes for teacher and student learning. However, analyses of meeting field notes, survey responses, and interview transcripts also illuminate how challenging engagement in improvement efforts can be. We have already discussed above some of the tensions that emerged. Below we focus on three specific challenges that characterised the work of the partnership.

Emerging challenges

Learning and change require emotional work

Comments on the difficulty and complexity of introducing change in classrooms and, more broadly, in the school and district culture, were frequent and mentioned by all stakeholders in interviews. Analysis of meeting field notes also documented several conversations and tensions around this theme.

The district leader commented on the emotional work necessary for educators at all levels to focus on improvement. His reflection highlights how change requires much more than just an acquisition of new knowledge or skills.

There are . . . times when, you know, you have to deal with some of the—I guess the way to put it—is your identity as an educator. And, you know, there is some, a lot, of tension there in relation to how I was or would have taught, in relation to what I've learned and know about how it really probably needs to be done. And so there's some emotion to work through there. There's some vulnerability that you've got to be willing to have . . .

Teachers used emotional language in their interview responses as well. Ms. C. discussed letting go of the textbook and sequencing lessons based on student understanding as 'scary:' 'And it's like I mentioned it, is a little scary not following a teacher's edition like we used to. We were used to following these day by day lessons.'

Ms. A commented on the difficulty of building on student thinking during instruction and on her self-confidence as a teacher:

I had to build confidence in my own teaching ability, and really recognize, I can't just tune out to one as soon as sharing. I really need to actually think about what my next question might be . . . And I'm a type of person that I feel like I have to be prepared. I need to have it written down. But it's all you know, it's all organic in the moment. So that really worried me at first and made me so nervous . . .

Similarly, Ms. L. used the terms 'struggle' and 'frustration' that come with change:

If I'm asking you a question, is that really telling you the answer? Or is it letting you figure it out on your own? That was the hardest for me. Am I leading too much? Am I not? . . . when you see the students struggle, you're always, want to jump in and just kind of hold their hand through it or even tell them the answer. So they don't feel the struggle. But I think, you know, constructive struggle is good for me and the kids, because sometimes I'm just sitting there like, ah! frustration you know. But yeah, that was my hardest thing was trying to figure out the questions to ask.

Developing a vision at the district level

Another theme that emerged from field notes and interviews related to the constraints and culture of the school and district office that made a focus on adult learning challenging at times and complex to enact. As we discussed above, all stakeholders converged on the importance of seeing adults as learners to be able to engage in productive improvement. At the same time, several challenges were mentioned.

Structuring the school day to provide opportunities for teachers to engage in sustained inquiry around their teaching was extremely difficult. When coordinating adult learning in school settings, it is essential to create coherence around a shared vision of high-quality teaching and learning and to provide specific expertise (in our case around mathematics pedagogy and pedagogical content knowledge), that can support teachers and leaders to build the necessary knowledge and overcome struggles that come along the way. One challenge the partnership encountered was to find settings and time to develop a shared vision of high-quality maths instruction and of adult learning among leaders at the district office (as mentioned by the district leader above), that would lead to the realisation of needs the district had in the area of mathematics teaching and to spending resources to

build the needed capacity. These inward reflections require a shift from focusing on accountability and outward messaging to focusing on learning and improvement, as suggested by the district leader comment above.

Managing multiple external demands

The orchestration of teacher learning at the school site was further complicated by the demands that the district office put on the teachers in relation to assessment of students' mathematics learning and other priorities outside the focus on mathematics instruction.

The leadership team discussed extensively existing student assessment systems for the extent to which they were aligned with the current vision of mathematics learning and designed for teachers to easily make decisions about next steps in instruction. This led to a change in district mandated math assessments for the lower grade classrooms. Teachers were allowed to use an assessment that was designed to monitor student progress in conceptual understanding as measured by open-ended math tasks, instead of multiple-choice questions. This switch did not extend to upper grade levels because it required the district to let go of interim assessments that were intended to predict performance on the end-of-year state assessment. Such a change had to involve more conversations at the district office. It had repercussions for the accountability system in place and unveiled different visions for the role of interim assessments as either tools for accountability or tools for teacher learning and improvement.

Another topic of discussion related to centralising communications from the central district office departments to schools and teachers to limit conflicting requests and messaging. This is a challenge that is exacerbated at the elementary school level because teachers teach all subjects, making concentrating efforts on a few priorities difficult, especially in schools where the urgency of improving student learning in many areas might be in conflict with the necessity to maintain a sustained focus on only a few priorities to allow for enough time and resources to be dedicated to them.

Discussion and conclusions

Responding to a need in the literature to provide concrete examples of school efforts to improve instruction (Honig and Hatch 2004), we have documented how a research-practice partnership centred on mathematics teaching and learning crafted coherence around its improvement goals by centring its efforts on learning and collaboration among adults. Through sharing themes that emerged during team meetings and interviews with teachers, school and district leaders and the math coordinator, we have illustrated how different stakeholders crafted coherence by navigating interactions and tensions (Johnson *et al.* 2016).

The collaborative settings supported the work of both the improvement leadership team and the teachers. Specific activities and tools, such as charting and conjecture mapping, that are commonly used in improvement science and design-based research (Penuel *et al.* 2011, Sandoval 2014) supported the identification of goals and the definition of plans for designing the teacher professional development experiences as well the development of a shared vision for teacher learning. The process the partners engaged in and the artefacts that the team created supported the partnership in navigating the complexity involved in rolling out and sustaining improvement efforts in schools. Interviews provided rich data on ways various stakeholders experienced the efforts, making visible the nuances and tensions involved in crafting coherence and maintaining a focus on teacher voices and needs.

While the positive outcomes of the partnership and particularly the learning that occurred among all stakeholders should not be underestimated, the partnership also encountered challenges. These challenges are not unique to the particular context in which the project was conducted, rather they reflect the difficulty documented in the literature in navigating complex organisations such as

school districts with educational infrastructures that can support, but also limit change (Coburn 2004, Honig and Hatch 2004). In our case, the existing assessment system created roadblocks for teacher classroom implementation. Changes were complicated by routines and norms around accountability systems that are routed both in state level policies and in local practices and beliefs.

The challenge of navigating multiple demands and sometime conflicting messages from the district office highlights the complexity of crafting coherence within district central offices. As documented by prior research, districts are not monolithic entities (Munter and Wilhelm 2021) and multiple visions and priorities often co-exist.

Other challenges seemed more personal and related to the frustrations that come with change and with learning something new and with the emotions involved in looking back at one's choices and having to reconsider them. Overall, this study contributes to the limited literature on PD as a means to create coherence. The findings highlight the affordance of working in partnership to design opportunities for stakeholders, including teachers, to illuminate contradictions and tensions, and to negotiate solutions towards improved alignment (Lindvall and Ryve 2019). The research-practice partnership was deliberate in designing spaces and routines for all stakeholders, both at the school site and at the district office, to engage in joint work that created supportive environments to engage in the hard work of instructional improvement, including building a shared vision for high-quality classroom teaching and high-quality teacher learning. When a shared vision was evident, it supported improvement efforts at the school site. When the vision was lacking, challenges became difficult to overcome and pathways through the complexity of district infrastructure and practices difficult to navigate.

Acknowledgement

The authors would like to thank the school leader for engaging in this work with an open mind and true devotion to improving children's opportunities to learn. Many thanks also to Christopher Wegemer for conducting the interviews with the leadership team.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The work was supported by the Orange County Education Advancement Network, UC Irvine School of Education.

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