# PROFESSIONAL LEARNING AT SCALE: DESIGNING A BOUNDARY OBJECT

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*Education policies and innovations that aim to improve instructional quality often fail to produce any meaningful or sustained changes to teaching when implemented at scale because of the significant learning demands they place on the individuals, groups, and organizations that comprise an educational system. In this paper, we describe an implementation resource developed to promote professional learning and cross role discussions about new state mathematics standards and report on the ways educators at different levels of the state system used them. Results demonstrate how implementation resources designed to be a boundary object for educators at multiple levels of an educational system have the potential to support learning and create systemic conditions conducive of change.*

Keywords: Policy, Systemic Change, Standards, Professional Development

In the US, education legislation, innovations, or policies aimed at improving instruction and student learning at scale have seldom led to even modest lasting improvements to teaching (Coburn et al., 2016). Critical scholars, policy researchers, and implementation scientists have offered various explanations for why large-scale educational reform remains elusive, one of the main ones being that it requires significant individual and organizational learning (Fullan & Pomfret, 1977). Initiatives are often implemented quickly, ignoring the time, structures, and resources needed to support the significant shifts required of teachers and teacher leaders. When working with smaller scale initiatives, teachers, curriculum leaders and/or mathematics teacher educators can come together and engage in professional learning experiences over time and in context. In contrast, when working with sweeping changes at scale we need to consider what structures and resources can support professional learning across all roles in ways that are aligned with what we know about effective professional learning experiences (PD).

In the context of this study, our focus was on the state-wide implementation of new high school mathematics standards. The State Board of Education adopted the standards in June with implementation expected in August. In response, our partnership of state and district leaders, mathematics education researchers, and classroom teachers quickly went to work designing structures and resources for state-wide, cross-role, professional learning experiences to support all stakeholders during the implementation. One of the key messages that accompanied the roll-out of the new standards was that they were based on research on teaching and learning. Through formal and informal feedback, stakeholders expressed that they wanted to know more about the research in which the standards were grounded. To address this need, a new set of resources were created and included in a multi-pronged professional learning structure—a collection of 20 two-page Research-Practice Briefs (R-P Briefs). These R-P Briefs were widely accessed and referenced by our stakeholders which left us wondering how the purposeful design of the R-P

Briefs contributed to their widespread use and in what ways the design features supported our stakeholders as they implemented the new standards.

## Background

Much research has been done concerning the core features of effective professional learning experiences for teachers (e.g., Wei et al., 2009). Whether in person or online, effective PD provides opportunities that are responsive to the needs of participants, of sufficient duration, content focused, include active learning, driven by teachers' work with students, while also being focused around communities of practice and connected to solving a problem of practice (e.g., Desminone, 2009; Mantranga & Silverman, 2020; Wei et al., 2009). Implicit in these descriptions is that effective PD needs to be guided by research on teaching and learning (Loucks-Horsey et al., 2009). For example, PD focused on supporting students' developing number sense might be grounded in research on cognitively guided instruction (e.g., Carpenter et al., 2015) and learning trajectories (e.g., Clements & Sarama, 2009). While PD focused on supporting teachers' facilitation of whole class mathematical discussions might be grounded in the research on noticing mathematically significant pedagogical opportunities (Leatham et al., 2015; Stockero & VanZoest, 2013). Further, participants benefit from opportunities to interact with research through discussion, productive debate, and social interactions because research and its use are a social process (e.g., Nutley et al., 2007; Tseng, 2012). However, engaging with research in these ways is challenging as there are many barriers that make such engagement difficult to bring to fruition, especially in the context of addressing fast paced initiatives. Such barriers include addressing structural issues of access, time, and designing for engagement.

One of the most basic barriers to interacting around research is access (e.g., Hemsley-Brown & Sharp, 2003; Shkedi,1998). Since much research is hidden behind paywalls and protected by copyright laws, addressing a state-wide interaction around research is complicated by the reality that many stakeholders cannot access it (Shkedi, 1998). Even if it was accessible, there is the reality of the time it would take to read and make sense of primary resources (e.g., Behrstock et al., 2009; Hemsley-Brown & Sharp, 2003). It is widely acknowledged that the current structure of teachers' work day does not provide sufficient time for the everyday work of teaching, let alone time for professional learning. To address these concerns, researchers have created open-access research briefs as a way to disseminate research (Anderson et al., 2019); the idea being to present research in a format that is widely accessible, synthesized around a narrow topic, and easy to read in a short amount of time. The potential of this format to address accessibility led us to wonder how we might leverage it as a resource to support professional learning. To do so would not only require that we align its contents with the features of effective PD, but also that we consider how its design might encourage and support interactions around it.

## Context & Theoretical Perspectives

This study took place in the context of a statewide research-practice partnership (Penuel et al., 2015) that focused on a shared problem of practice − improving the implementation process for new high school mathematics standards. Our first goal was to co-design and study a statewide professional learning initiative to support implementation efforts. Our co-design efforts follow from a theoretical perspective of communities of practice (Lave & Wenger, 1991; Wenger, 1998). Because practice is a defining characteristic of a community, communities are formed by collaboratively engaging with common resources toward a common goal. Though boundaries of practice distinguish communities across the social landscape, they are also a source of new learning. Boundary encounters allow for members of distinct communities to jointly negotiate

meaning around boundary objects—artifacts that carry meaning in multiple communities and support the coordination of practices across them (Star & Griesemer, 1989; Wenger, 1998).

Many resources were co-developed in support of the partnership initiative and were intended to act as boundary objects. These included (but were not limited to) online PD modules, instructional frameworks, and the collection of R-P Briefs. Our hope was that each of the resources would become a boundary object, in that they would support knowledge exchange across the many different communities in our partnership (e.g., teachers, math leaders). The design principles for the R-P Briefs were initially informed by the literature on effective PD and refined over time through feedback from the statewide co-design network via surveys and focus group interviews. Ultimately, 20 R-P Briefs were developed, one for each unit of instruction across three different high school mathematics courses. Each R-P Brief was exactly 2 pages long and included: explanation of vertical alignment of the mathematics in the unit (both within the course and across courses), description of why the mathematics concepts included are important, at least one example task, research on students' mathematical thinking and learning related to the big mathematical ideas in the unit, research on effective pedagogy specific to the unit, explicit attention to connections to the Standards for Mathematical Practice (SMPs), and discussion questions to consider with colleagues.

The R-P Briefs were disseminated within online PD modules, on the partnership's website, and in many state, regional, and local meetings (e.g., sessions at state affiliate NCTM conferences). The number of downloads for each R-P Brief at the time of this study from just the online PD modules, are shown in Table 1. The download data, coupled with the other ways we were aware they were being accessed, indicated that the briefs were widely used, which prompted us to wonder if our intentional design played out like we expected—to support teacher and teacher leader learning about the standards themselves and the research that informed them, as well as their implementation of the standards.

**Table 1: Number of Canvas Downloads as of July 2018**

| Math 1 Briefs (n=6) | Number of Downloads | Math 2 Briefs (n=6) | Number of Downloads | Math 3 Briefs (n=8) | Number of Downloads |
|---|---|---|---|---|---|
| 1.1 | 416 | 2.1 | 593 | 3.1 | 693 |
| 1.2 | 455 | 2.2 | 105 | 3.2 | 152 |
| 1.3 | 111 | 2.3 | 302 | 3.3 | 212 |
| 1.4 | 82 | 2.4 | 84 | 3.4 | 72 |
| 1.5 | 262 | 2.5 | 30 | 3.5 | 218 |
| 1.6 | 68 | 2.6 | 9 | 3.6 | 45 |
| | | | | 3.7 | 84 |
| | | | | 3.8 | 78 |
| Total | 1394 | | 1123 | | 1554 |

## Methods

This study used survey methods to build an understanding of how the R-P Briefs supported teacher learning about the implementation of new mathematics standards. To that end we aimed to address the following research questions: What aspects of the R-P Briefs do math teachers and math leaders say are helpful?; How do math teachers and math leaders say they use the R-P Briefs?; and What actions do math teachers and math leaders that use the R-P Briefs say they take as a result of reading them?

The partnership developed and administered a survey in Spring 2018 to inform its ongoing efforts to support standards implementation. Respondents were assigned to sets of questions

specifically addressing the partnership's implementation resources and supports developed for their grade band. In this report, we focus on the set of questions addressing the R-P Briefs which was assigned to those identifying they worked in the high school grade bands.

The survey was distributed through the state agency's listservs to approximately 20,000 mathematics teachers, school administrators, and district mathematics leaders. A total of 1,768 educators from 96% of the state school districts accessed and completed at least 80% of the survey. Here, we report on responses from the 346 educators from 85 of 115 school districts who had an opportunity to respond to the set of questions focused on the R-P Briefs. The questions in this block asked participants if they were aware of the R-P Briefs. The numbers were about evenly split with 184 people (53%) said they were aware and 162 (47%) said they were not aware. The remaining analysis is based on the 184 people who were aware of the R-P Briefs. This includes responses to three survey items. The first two asked about how participants used the R-P Briefs and which aspects of them they found helpful. These were both "select all that apply" items. The third was an open response item that asked, "What are some of the actions you have taken (if any) after engaging in the research-practice briefs?"

The responses to the first two questions were analyzed by determining frequencies and percentages for each response option and then disaggregated by role group (e.g., teacher, math leader–i.e., school-based coaches, district curriculum leaders, school administrators). To analyze the responses to the open-ended, all members of the research team first read all of the responses to become familiar with their contents, making memos of common themes that emerged. This process and the ensuing team discussion led to the generation of five codes that captured the range of participants' actions with the R-P Briefs. Using our set of codes (e.g., planning, learning/reflection, shared with others, lead PD, guide curriculum decisions), each team member individually coded the participants' responses. Any coding disagreements were reconciled through group discussion. In the following sections we report the results of our analysis with respect to each of the research questions.

## Findings

### Useful Features of the R-P Briefs

The survey question that asked about the usefulness of particular features of the R-P Briefs was multiple response in format with answer choices aligned with the 7 design principles for the R-P Briefs described above. The design features that were selected as useful by more than half of the respondents were vertical alignment and tasks (51% and 53% respectively), with the description of why the topic is important being the least useful (9%). Disaggregating the data, revealed teachers and math leaders find some features similarly helpful, but respond quite differently to others. For example, while 48% of math leaders indicated that the discussion questions to consider with colleagues were useful, only 13% of the teachers selected this feature. While not as dichotomous, there are similar results for the research features and the SMPs. Such results suggest that usefulness of features may be aligned with how they are connected to one's daily work responsibilities as teachers and math leaders, while both are responsible for the implementation of the standards, they each have different roles in the implementation process.

**Table 2: I find the following aspects of the R-P briefs useful [Select all that apply]**

| | All Participants (n=184) | Teachers (n=138) | Math Leaders (n=46) |
|---|---|---|---|
| Vertical alignment (grade/course distinctions) | 51% | 47% | 63% |
| Description of why a topic is important | 9% | 9% | 7% |

| | | | |
|---|---|---|---|
| Tasks/Examples | 53% | 52% | 57% |
| Discussion questions to consider with colleagues | 22% | 13% | 48% |
| Research on students' mathematical thinking and learning | 29% | 22% | 52% |
| Research on effective mathematics pedagogy | 27% | 17% | 57% |
| Explicit attention to the Standards of Mathematical Practice | 27% | 23% | 37% |
| Other | 2% | 2% | 0% |

**How the R-P Briefs are Being Used**

The survey question that asked about how the R-P Briefs are being used was multiple response in format with answer choices that were aligned with not only the design elements of the R-P Briefs, but also the intention of sharing related research on teaching and learning in a usable way (See Table 3). High response rates on learning more about the mathematics of courses taught (54%), supporting instructional decisions (43%), and gaining more resources for instruction (57%) speak to the immediate needs of teachers in their daily work, but also indicate a valuing of what research says about teaching and learning by the teacher respondents. Math leaders also found the R-P Briefs useful for instructional decision making and resources (43% and 59%, respectively). This shows that as a boundary object, the two communities found common purpose for the R-P Briefs in addressing the overlapping aspects of the work of the two communities—supporting and implementing mathematics instruction.

**Table 3: I use the R-P Briefs to … [Select all that apply]**

| | All Participants (n=184) | Teachers (n=138) | Math Leaders (n=46) |
|---|---|---|---|
| Learn about content for the math courses I teach | 49% | 54% | 35% |
| Learn about pedagogy for the math courses I teach | 36% | 36% | 35% |
| Learn about vertical alignment from previous math courses | 42% | 46% | 30% |
| Participate in discussions with colleagues in informal settings | 19% | 15% | 30% |
| Participate in discussions with colleagues in formal settings | 32% | 25% | 52% |
| Support my instructional decisions | 43% | 43% | 43% |
| Share information with my principal, colleagues, or district level personnel | 16% | 8% | 41% |
| Get instructional resources | 58% | 57% | 59% |
| I am familiar with the [blinded] briefs, but I do not find them useful | 4% | 5% | 0% |
| Item left Blank | 21% | 21% | 20% |

Stark differences in the ways these two communities (i.e., teachers and math leaders) say they use the R-P Briefs appear in the collaboration-related response choices and vertical alignment. While some teachers used the R-P Briefs in formal or informal discussions with colleagues, a larger proportion of math leaders responded with the use of the R-P Briefs in this way. In particular over half of the math leaders responded that they use the R-P Briefs in formal settings. Further, only 8% of teachers indicated that they shared the tool with colleagues, compared with 41% of math leaders who reported that they had shared the R-P Briefs. Another distinction in how the tool was used by the different communities appeared when considering the learning about mathematics content choice alongside the vertical alignment choice. These

response options speak to the usefulness of the R-P Briefs for teachers in situating these new courses within the K-12 continuum, an aspect also valued by math leaders but to a lesser extent.

**Actions Taken as a Result of Engaging with the R-P Briefs**

Of the 184 people that responded to the R-P Briefs question block, 107 of them (76 classroom teachers, 31 math leaders) responded to the open-ended item asking them to describe some of the actions they have taken (if any) after engaging with the R-P briefs. The results suggest that actions tended to be related to classroom level lesson planning, personal learning or reflection, sharing the R-P Briefs with others, using them when leading professional development, and using them to guide school or district-level curriculum decisions (see Table 4). In essence, this question ended up providing an opportunity for people to provide further detail regarding how they are using the R-P Briefs.

**Table 4: Percent of Participants that Noted an Action by Theme**

| | Planning | Learning and/or Reflection | Shared with Others | Lead PD | Guide Curriculum Decisions |
|---|---|---|---|---|---|
| Teachers | 70% | 37% | 20% | 3% | 4% |
| Math Leaders | 1% | 23% | 52% | 26% | 13% |
| Total | 52% | 33% | 29% | ~1% | ~1% |

The most common actions described by teachers were different from those described by math leaders. Teachers overwhelmingly noted that they used what they gleaned from the R-P Briefs to inform their lesson planning and/or to reflect on their own learning. In contrast, math leaders most commonly noted they physically shared the R-P Briefs with others and/or used them when leading professional development. In the sections that follow we provide further description of the actions described in each of these categories.

**Classroom level lesson planning.** As we saw earlier, many respondents noted they used the R-P Briefs to support their instructional decisions and to get instructional resources. Consistent with that finding, almost three-quarters of the teachers that responded to this item described the ways they adjusted their classroom level lesson plans based on what they learned from the R-P Briefs. For example, T47 noted "I adjusted my lessons based on the research", and T49 wrote "I have implemented some of the tasks suggested". One of the most common planning actions was related to adjusting instructional emphasis based on the vertical alignment feature. For example, T22 wrote "Used for adjusting my instruction to better meet the curriculum without going too far", T33 wrote, "Tweaked emphasis on units, placing less emphasis on some topics and increasing others.", and T74 wrote, "Honing in on the exact type problems my students will have to pass. In the past it has been too broad and this helps streamline materials." In fact, with the exception of the "discuss with your colleagues" feature, all of the R-P Brief features emerged as being used to inform classroom level planning in some way.

**Personal learning or reflection.** From the previous question, we know that teachers and math leaders used the R-P Briefs to learn about content, pedagogy, and vertical alignment. The open-ended responses that were focused on personal learning or reflection add to this picture because they highlighted participants' attention to research on student thinking or pedagogy. For example, T16 notes using the R-P Briefs toward "Trying to better understand how students' think", and T43 noted "I have used these to gain a deeper understanding of what my students need to engage them in the mathematics outside of everyday calculations." The most referenced aspect of the R-P Briefs was the vertical alignment of content. This seemed to support teachers

and math leaders in understanding how the standards are situated both within and across courses. For example, T11 noted:

> For me, the briefs give me a better understanding of the depth of understanding the course is expected to achieve. In the past, I always went way too deep and students and parents would come back and say the student learned nothing in the next course or two that the learner took because too much had been covered. Knowing when to stop was a major challenge in the past. I can now see more clearly and confidently that concepts will be covered in due course and I did not have to feel responsible for getting the learners through too much material.

These responses indicate that not only did the teachers and math leaders go to the R-P Briefs with the intention to learn and reflect, but also that they found the features related to vertical alignment and research on teaching/learning to be the most impactful when they took this action.

**Sharing the R-P Briefs with others.** Across all roles, participants acted by sharing and discussing the R-P Briefs with others. There are examples of sharing and discussing the R-P Briefs with peers, administrators, and even parents. In some instances, it is unclear if sharing simply means giving the R-P Brief to someone else with no additional interaction (e.g., "Shared briefs with preservice teachers", T48). In other instances, it is clear that the sharing included interacting with each other around the R-P Brief in a meaningful way. For example, T46 responded, "I have had numerous planning meetings with the math 2/3 teacher at our small school to ensure we are using similar research based practices for teaching." and TL87 wrote, "Sharing information from the briefs with administrators and teachers. Encouraging use in Math PLCs." These responses give us a sense of how the R-P Briefs might land in the hands of people that might not have otherwise seen them and they illustrate how various communities (e.g., departments, professional learning teams, friendly colleagues) might be interacting around them.

**Leading professional development.** While we know the R-P Briefs are being shared and discussed, there is also evidence that math leaders are using them in their professional development work. This includes both formal professional development sessions and one-on-one coaching. For example, TL96 noted, "I have used them in PD with my district to try to get buy-in for using tasks on a regular basis." While TL103 explained, "I use them in facilitating discussion with the teachers I coach." These actions suggest that the briefs enabled connections between communities and were helpful in making meaning across boundaries.

**Guide school or district level curriculum decisions.** Among the many ways that participants said they acted on the R-P Briefs were actions to guide both school level and district level curriculum decisions. For example, TL85 noted,

> The briefs were used in each Math 1 and Math 2 Professional Learning session to discuss the vertical alignment of the mathematics and to understand the focus of the content for the unit for the course. The briefs are a part of the Math 1 Unit Framework that is currently being developed in our district.

Similarly, TL92 responded "Curriculum decisions - pacing, order of content, etc. for district-level documents." These actions are different from classroom level planning noted above in that such decisions affect teachers and students across a system.

## Discussion & Conclusion

This study was motivated by a need for designed structures and resources that supported professional learning related to the implementation of large-scale educational innovations. In our case, this was the implementation of new state math standards. Given that our theory of learning

is grounded in communities of practice (Wenger, 1998), any resources we designed were intended to be boundary objects–spanning the boundaries of the multiple communities of stakeholders in the system. Our findings suggest that the R-P Briefs not only supported professional learning as intended, but also acted as a boundary object in ways beyond those for which it was originally designed.

Our design principles were informed by the research on effective PD. Findings suggest that all but one of these features was seen as useful to at least 20% of the respondents, the only exception being the explanation of the usefulness of the mathematical concept. This exception is likely explained by the fact that the participants already know why the content is useful (they are math folks). Thinking about the R-P Briefs as both a resource to support learning and as a boundary object, the findings shed interesting light. First, there is evidence that the R-P Briefs physically crossed community boundaries. They were shared and/or discussed in communities of teachers, communities of math leaders, communities of teachers and math leaders together in a school, and even communities of teachers, parents, and students in a single class.

Second, Star & Greisemer (1989) describe boundary objects as, "objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (p. 393). Looking at the two communities of focus, teachers and math leaders, the findings indicate that some of the R-P Brief features were found equally useful within each community, suggesting that these features mean something to both. Yet there were other features that seemed more useful to one community than the other. This coupled with the finding that different communities are using the resources in different ways, suggest that an important design feature of the R-P Briefs was including content that was recognizable and meaningful to both communities yet presented in a way that it was malleable enough to be used by the different communities in different ways. Ultimately, we designed the R-P Briefs to be boundary objects, and the findings indicate that they in fact are.

For others considering how such a resource might support work in a different context, our findings suggest that in addition to designing based on what is known about effective PD, design should attend to the needs of the communities you hope to span. Specifically, design principles should include some features that are recognizable and important to multiple communities to support the development of a common language and an avenue for important boundary encounters, while also including features directly connected to the work of the individual communities. At the same time, we caution you to be careful about what is and is not included in the design and content. Findings here suggest that when a resource travels across boundaries in a large system, it develops power and could be used in ways that were not originally intended.

To date, over 10,000 R-P Briefs have been downloaded, and we know from the results here that people are accessing them in other ways as well. We have come to see the R-P Briefs as one example of a group of designs that our partnership developed to support systemic coherence in the implementation of new innovations. Like the briefs, other implementation resources were also grounded in research on teacher and student learning, instruction, and implementation. Collectively they provide access to safe professional learning opportunities and represent the expertise of a diverse set of educators within the system. Our hope is that findings from studies like this one can support others in designing implementation resources as boundary objects that support professional learning in the context of implementing educational innovations at scale.

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