Education Policy and the Learning Sciences:

The Case for a New Alliance

Mary Kay Stein

Kevin Crowley

Lauren Resnick

University of Pittsburgh

Learning is at the heart of every country's efforts to advance the standing of its youth and its economic competitiveness. Nations promote better learning through education policies that establish standards for student achievement, guidelines for textbooks, and requirements for testing. National standards, national curricula and national exams are all, in principle, aimed at improving the kind and extent of learning in a nation's schools. Coupled with state- or province-level policies and the decisions of local leaders, national policies are intended to work across entire nations, improving student learning on a broad scale.

But what does it take to improve student learning on a broad scale? The history of education reform in the United States offers few insights. Although past reforms have tried to change patterns of learning in our schools, few, if any, have penetrated the "core" of educational practice: teachers' ideas about the nature of knowledge and about student's role in learning, and how these ideas are manifested in teaching and classwork (Elmore, 1996). So, for example, although access to education has continually broadened—through the creation of the common school, the development of the comprehensive secondary schools,

the introduction of kindergartens—actual teaching practice has scarcely changed in a systematic or sustained way in more than a century (Tyack, 1995; Cuban, 1993). Most instruction is still teacher-centered; most students work most of the time by themselves on discrete tasks that require little independent thought or collaboration with others; and most tests and assessments focus on factual recall and aptitude rather than on reasoning and inquiry (Stigler & Hiebert, 2004). And yet, learning sciences research demonstrates that these practices result in ineffective learning (Brown, Roediger, and McDaniel, 2014; Sawyer, 2014).

Here, we argue that improving student learning on a large scale will require a new set of education policies that challenge the dominant paradigm on which the U.S. educational system is based and that support a new vision of education that is rooted in the learning sciences. Additionally, federal and state policy makers need to reach beyond evidence produced by one particular research design (experimental) and action guided by a limited set of policy instruments (mandates and incentives) to a variety of research traditions (as exemplified by the learning sciences) and a broader set of instruments (e.g., capacity building). In this chapter, we explicate why current policies have failed to improve American education, what issues are currently on policy makers' radar screens, and how the learning sciences are or could be positioned to contribute to a new era of policies that reflect what we know about how people learn (Bransford, Brown, & Cocking, 1999; Sawyer, 2014). Although the exact issues that stifle education reform differ across countries, we suspect that the basic challenges identified herein will resonate with many countries in the western world.

This chapter is divided into three main parts. First, we outline how we got to where we are today: essentially, an educational system that is unresponsive to the needs of students, the findings of learning sciences research, and the requirements of a globalized economy. Next, we zero in on a current policy issue that represents fertile ground for the cross-pollination of policy and the learning sciences: research on teacher learning and the design of environments that support teachers' development of the capacities needed to prepare students for an innovation- and knowledge-based economy. Within this section we describe two approaches for connecting work across policy and the learning sciences. The first grows out of an already established line of policy research; the second represents emerging work that brings together policy makers and researchers to jointly design innovative solutions for teacher learning. In the third and final section, we conclude by making the argument that the timing is right for a new alliance between policy and the learning sciences.

HOW WE GOT TO WHERE WE ARE TODAY

In the US, we are perpetually worried about the performance of U.S. students compared to their counterparts in other nations and what it suggests about the global competitiveness of the American workforce. Using data from the OECD's Programme for International Student Assessment (PISA), it would seem that U.S. students continue to compare poorly to students in other countries (Educational Testing Service, 2015). A steady stream of commissioned reports have warned that high-skill jobs are moving to countries in which workers can perform tasks more cheaply and often better than American workers (e.g., National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007). Leaders from business, industry, government, and education

tell the public that students need to move beyond basic literacy and "shopkeeper" arithmetic to master a new set of "21st century" skills. Although the details of what exactly constitutes 21st century skills may change from one policy document to the next, they share a common focus on adaptive learning that supports reasoning in ill-structured domains, inquiry, innovation, comprehending complex texts and visualizations, and collaborative problem solving (Trilling & Fadel, 2009). In this chapter we refer to the general class of 21st century skills as *ambitious learning* and the instruction required to support such learning as *ambitious teaching*.

Creating and enacting policies capable of changing an educational system from one focused on basic, minimum standards to one that will produce students who can think, reason, and problem solve is a tall order for which the history of educational reform provides limited guidance. The few cases of successful efforts to foster ambitious learning have not been linked to official policy structures; most successful "progressive programs" have been developed and implemented in private or laboratory schools (e.g., University of Chicago Lab School; Central Park East) and have never penetrated the heartland of American school systems (Elmore, 1996) where schools look and feel much the same as they did 200 years ago.

Why has raising the level of intellectual demand in American schools been so difficult? We have inherited an education system rooted in learning theories that reflect 20th century scientific assumptions concerning the nature of knowledge, effective mechanisms of learning and teaching, and individual differences in aptitude for learning. Through most of the 20th century, associationist theories of learning dominated, and they defined knowledge as aggregations of bits of unrelated information; learning as a form of practice

that would "stamp in" correct bits and eliminate incorrect ones; and aptitude as a fixed capacity for learning. These assumptions about knowledge, learning and aptitude were challenged during the decades of the cognitive revolution by studies showing that students' learning in complex domains is shaped by prior knowledge (Glaser, 1984), that it involves active, constructive processes on the part of the learner (Resnick, 1987), and that it is integrally interwoven with language and other forms of social interaction (Wertsch, 1985).

Despite these advances in learning theory, outdated associationist views remain firmly ensconced in the standard operating procedures of today's schools, which Papert (1993) referred to as *instructionism* (also see Sawyer, 2012). They continue to constrain reformers' efforts to raise the level of intellectual demand. These fossilized views of learning are pervasive—impacting the design of assessments, norms of instructional practice, teacher training regimes and curricula. Together they compound and reinforce one another: Exams that test for "bits" of knowledge engender a view of instruction in which the teachers' role is to teach these bits of information—usually isolated facts, skills, rules and procedures. Teaching thus becomes the transmission of information directly through definitions, demonstration of skills, assigning plenty of practice, and checking student performance on a regular basis.

Standards as Policy to Improve Learning on a Broad Scale

The introduction of curriculum standards in the early 1990's represented an important policy-based effort to target classroom practice as a means of moving the country toward more ambitious forms of student learning. Standards for what students should know and be able to do were set forth, first by professional organizations such as the National Council of Teachers of Mathematics and later by states under President George

Bush's No Child Left Behind legislation (NCLB). These standards constituted an unprecedented reach by policy makers into matters of teaching and learning inside the classroom. The good news is that the best of them were rooted in cognitive and learning sciences research (e.g., Kilpatrick, Martin, & Schifter, 2003).

The standards movement was promising not only because of its ties to contemporary learning research but also because it was accompanied by a growing recognition of the need for change not only inside classrooms, but also in other elements of the education system (Smith & O'Day, 1990). Studies documenting how teachers received multiple, often conflicting, messages regarding what and how to teach (e.g., Hatch) led to calls for the establishment of new state policies that aligned assessment, curriculum and teacher training to the new standards. With the passage of NCLB in 2000, alignment became the law. Federal policy mandated that states design or adapt standards for K-12 education and build assessments that were aligned to those standards (in grades 3 – 8). NCLB also imposed consequences on schools whose students did not reach those standards as measured by their performance on the new assessments. Although all of this policy-driven activity stopped short of establishing national standards or a national test, it did propel schools and teachers toward greater alignment with a set of public and shared learning objectives than had previously been the case.

It was not long, however, before this experiment of policy-in-the-classroom began to falter (Kahlenberg, 2008). Although there was increasing evidence of alignment to shared goals, most often that alignment was to low-level forms of knowledge (Porter, 2002; Webb, 1999). The old and familiar behaviorist assumptions about knowledge, learning, and

aptitude had re-asserted themselves, in part, perhaps, because they were much easier to assess, specify, and teach than was ambitious learning.

Much of the blame was laid at the foot of new state assessments and the accountability structures that accompanied them. The combination of state tests designed to test mostly low-level skills (despite high-level standards) and states' authority to set proficiency cut points at arbitrarily low levels, had resulted in a "race to the bottom" as state after state managed to meet federal accountability targets while making little real change in instructional practices or student learning outcomes. What is more, as state tests became the new, tacit blueprint for what students should learn, the curriculum became narrowed to those facts that students would be expected to know for the test (Center on Education Policy, 2008; Shepard, 2003). The net result was that the educational system ended up further away from the goal of achieving ambitious learning goals, when the policy's original intention was just the opposite. In reaction to these problems, a consortium of states has produced a set of common standards in mathematics and literacy (known as the Common Core State Standards), *along with two assessments aligned with those standards*. At the time that this chapter is being written, the exams have not yet been widely administered but they are expected to align with ambitious forms of teaching and learning.

The above illustrates how unexamined "standard operating procedures," based in outmoded theories of learning, hijacked well-intentioned policy efforts to raise the level of intellectual demand of American education. Interestingly, during this era, policy making itself reflected associationist assumptions as revealed by the instruments policy makers selected to accomplish their goals. Policy instruments are the "mechanisms that translate

substantive policy goals (e.g., improved student achievement, higher quality entering teachers) into concrete actions" (McDonnell & Elmore, 1987, p. 134). Four general classes of policy instruments are *mandates* (rules intended to produce compliance), *incentives* (transfer of money in return for certain actions), *capacity-building* (transfer of money for the purposes of investing in material, intellectual or human capital), and *system-changing* (transfer of authority in order to alter the system by which public goods and services are delivered). Each of these are based on a different assumption about the nature of the problem that policy is attempting to solve and under what conditions a particular instrument might be most effective. During the NCLB era, policy makers relied heavily on mandates and incentives, both of which assume capacity to enact the policy coupled with the need for enforcement (punishment or incentives) in order to assure its enactment, and both of which continued to distract attention away from the learning in which teachers needed to engage in order to carry out the policies.

Compounding the problem, the NCLB era also saw the rise of a strong preference for randomized control trials as the gold standard for evidence of effectiveness. These studies are powerful ways to test intervention at scale because they involve random assignment to intervention or control group and often use standardized student outcome data as dependent measures. But the designs are input-output models that "black box" instruction and other meditational processes, and they are not able to shed light on the nature of the implementation processes, including the capacities of individuals within the system and the conditions under which they are expected to learn the new practices. So just at the moment when policy makers might have been helped by higher-resolution information on the processes of implementation and the conditions that support it, many

educational researchers were moving in exactly the opposite direction.

The central claim of this paper is that progress toward ambitious student learning on a broad scale depends on replacing the dominant associationist-based system with new policies that will demand and support ambitious learning and teaching at scale. The learning sciences are primed to contribute to these new polices because of their commitment to participatory, constructivist and collaborative pedagogies that yield deep conceptual understanding and meaningful styles of thinking and reasoning (Sawyer, 2014). By highlighting the constructivist and social/contextual dimensions of learning (Brown, Collins, & Duguid, 1989; Greeno, Collins, & Resnick, 1996; Lave & Wenger, 1991; Rogoff, 1991; Tharp & Gallimore, 1988) the learning sciences are growing a body of knowledge that focuses squarely on the kind of information needed to guide schools of the 21st century.

TEACHER LEARNING FOR MORE AMBITIOUS
STUDENT LEARNING

The issue of teacher quality has jumped onto the radar screens of policy makers in the past decade. Using sophisticated statistical methods such as value-added modeling, economists have been able to isolate the effect that a teacher—as opposed to students' prior achievement or SES status—has on student achievement (e.g., Harris, 2009; Rivkin, Hanushek, & Kain, 2005). Despite the fact that these studies have not found particularly large teacher effect sizes, economists' attention to teacher effects has led to a "buzz" in the policy community around teachers' role in student achievement. However, because economists' research designs do not include attention to instructional practices, these studies have not shed light on what it is that effective teachers actually do. At its worst, this

attention has led to calls to hire good teachers and fire poor teachers. At its best, it has led to a growing consensus of the need for policy to pay attention to improving the instructional practices of the teachers we do have.

Accompanying the call for high-quality teachers must be the acknowledgement that—as the bar has risen for student learning—so too has it risen for what constitutes high-quality teaching. No longer will it suffice for teachers to transmit procedures and facts; rather they must learn how to select and pose authentic tasks and orchestrate discourse that shapes students thinking toward deep conceptual understanding and more sophisticated forms of thinking and reasoning. Additionally, these new learning goals for teachers bring into question policymakers' traditional reliance on the policy instruments of mandates and incentives. Policies cannot simply *mandate* the teaching of ambitious programs and expect those programs to be taught well; nor can policies simply provide *incentives* for teaching these programs because the use of incentives assumes teachers *already know how to teach* in ways congruent with the program, but are simply holding back until they are appropriately incentivized.

Policy maker's attention to teacher quality provides an opening for research on teacher learning that the learning sciences can and should take advantage of. At first glance, learning scientists may not appear to be well positioned to contribute to policies that reflect an understanding teachers' learning needs or to the design of environments for improving teaching practice. Although critical to implementing and co-designing optimal learning environments, teachers—and their learning—have for years been backgrounded by learning sciences researchers who were often more interested in student learning and the design of curricula and tools for *student* learning (Fishman Davis, & Chan, 2014). Yet,

interest and activity surrounding teacher learning has accelerated during the last decade (Fishman et al, 2014). This acceleration is consistent with the learning sciences' long standing commitment to design studies as a methodology for both developing learning theory and improving educational practice (e.g., Brown, 1992). Designed-based research privileges information about the dynamics of a learning situation and focuses attention on interactions between learners, teachers, tools, and settings. There is a long and rich history of design-based research in the learning sciences (Barab, 2014), as well as a recent move towards design-based implementation research where researchers and practitioners jointly create research questions, design interventions, and consider evidence at the larger scales of districts and systems (Cobb, Zhao, & Dean, 2009; Penuel, Fishman, Cheng, & Sabelli, 2011). As the gap continues to close between the research questions in the learning sciences and authentic problems of educational practice, we predict that teaching will loom increasingly large on the learning sciences landscape and look forward to a rapid expansion in what learning scientists know, and thus can communicate to policy makers, about how teachers learn and how they can best be supported.

To help facilitate this growth we explore two approaches to integrating learning sciences and policy around the issue of teacher learning. One builds on work that already has a history: policy implementation research. The other is less well developed, but perhaps represents the potential for even closer ties: design work that takes its cues from student learning and that is undertaken alongside district and state policy makers who, by the nature of their positions, must work at scale.

Policy Implementation Research

Policy implementation research examines how practice shapes the ways in which policies play out on the ground (Berman & McLaughlin, 1978; Majone & Wildavsky, 1977; Werner, 2004). The frameworks used to guide the earliest implementation research tended to assume that teachers automatically understood fundamental aspects of reform as intended by policy makers; failures of implementation were explained by factors that lay outside the learning process such as lack of supervision or monitoring, policy ambiguity or the autonomy of teachers who are viewed as acting solely in their own best interest (e.g., Weatherley and Lipsky, 1977). However, since the 1990s, implementation researchers have increasingly come to see the problem of educational policy implementation as one of teacher learning (Coburn & Stein, 2008; Spillane, Reiser, & Reimer, 2002). This new vision of implementation coincided with the advent of the first standards movement when policies began to put forth visions of instruction that departed substantially from most teachers' existing practice .

Using theory and research on basic cognitive processes, social cognition and situated cognition, policy implementation researchers now characterize teachers as "sense-makers" who interpret policy (Spillane et al, 2002). Rather than assuming that teachers "read" policy messages in ways that are aligned with policy makers' intentions, researchers focus on things such as how teachers' past knowledge might have influenced their interpretations (Jennings, 1996; Spillane & Callahan, 2000; Spillane & Jennings, 1997); how teachers often misunderstand new ideas embedded in policy messages, taking them to be something familiar when they are actually quite different (EEPA,1990); and on how teachers' understanding often focuses on superficial features of new policies, rather than deeper pedagogical principles (Coburn, 2004; Spillane & Zeuli, 1999).

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This more learning-oriented approach to the study of policy implementation is now the dominant stream of policy implementation research. It could be strengthened, however, by learning sciences research focused on the processes of teacher learning. For example, research that has established the role of prior knowledge in how teachers interpret new policies could be followed up by work that explores the kinds of interventions and subsequent learning mechanisms that can shift teachers' conceptions and practices toward more student-centered teaching. Some of this work has already begun, for example, research on how video can be used to assist teacher learning (Borko, Jacobs, Eiteljorg, & Pittman, 2008; Sherin & van Es, 2005; Sherin & Han, 2004; Goldman, Zahn, & Derry, 2014). Other kinds of knowledge produced by learning scientists that could be useful to understanding the learning processes associated with teachers' implementation of new policies include knowledge about scaffolding (Reiser & Tabak, 2014), metacognition (Winne and Azevedo, 2014),and learning through case comparisons (Alfieri, Nokes-Malach, & Schunn, 2013; Kolodner, 2014; Tekkumru Kisa & Stein, 2014).

An example of a line of work that has the potential to bridge the worlds of the learning sciences and policy implementation is theory and research on tools (e.g., Grossman, Smagorinsky & Valencia, 1999; Ikemoto & Honig, 2010; Vygotsky, 1978; Wertch, 1991) and the routines surrounding their use (Feldman & Pentland, 2003). Tools (e.g., curriculum materials, computer-based programs, observation protocols, rubrics) embody research knowledge in ways that are directly usable in practice. Because they are positioned—at least in theory—to influence large numbers of teachers and classrooms (Ball & Cohen, 1996), tools can be important for large-scale efforts to improve practice. Thus, research on tools and routines could contribute findings that learning researchers care about

(how tools afford the processes of learning) and that policy researchers care about (improvement at scale).

Social aspects of teacher learning. Research on policy implementation has also focused on the social aspects of teacher learning. These studies point to teachers' professional communities as a critical site for learning to implement new programs and practices (Bryk, Sebring, Allensworth, Easton, & Luppescu, 2010; Horn & Little, 2010; Little, 2003; McLaughlin & Talbert, 2001; Smylie & Hart, 1999; Sun, Frank, Penuel & Kim, 2013). Until recently, however, such research has given limited attention to the processes by which teacher learning in communities occurs. Researchers who have thought about the processes of teacher learning within professional communities have often turned to the learning sciences in general and the learning-as-participation metaphor in particular (Cobb, McClain, Lamberg, & Dean, 2003; Coburn & Stein, 2006; Franke & Kazemi, 2001; Gallucci, 2003; Stein, Silver, & Smith, 1998). Policy researchers' interest in communities of practice as an intervention for reform coupled with learning scientists' interest in learning through participation suggests that teacher-teacher interaction may represent another potential bridge between the worlds of the learning sciences and policy.

An alternative approach to studying teacher interaction uses social network theory and analyses to identify teachers' social resources for learning and improvement. This approach examines how the nature and quality of teachers' interactions with colleagues and administrators shapes their learning (Coburn, 2001; Frank, Zhao & Borman, 2004; Penuel, Riel, Krause & Frank, 2009) and their ability to sustain instructional reform (Coburn, Russell, Kaufman & Stein, 2012). Findings suggest that teachers' interactions provide access to instructional expertise (Frank, et al., 2004; Penuel et al., 2009), enable them to

learn from one another (Gersten, Chard, & Baker., 2000) and provide normative pressure to engage in new practices (McLaughlin & Mitra, 2001). Some recent research that utilizes a social network approach has begun to establish explicit links to learning theory by examining not only frequency and closeness of one's ties to others (a typical dimension examined by social network theorists), but also the content and depth of their interactions (Coburn & Russell, 2008; Coburn et al, 2012). This line of work also links to policy by identifying the actions that district policy makers can take to encourage teachers' use of social resources to support implementation of ambitious programs and practices.

The move toward tighter coupling of implementation research and learning sciences research advocated for above foregrounds *the study of* learning processes and the building of basic knowledge through descriptive analytics, often in situations that take advantage of naturally occurring variation. Although the investigators may be pursuing a long-term agenda of educational change, designing and improving are not in the first position inside each individual study. Rather the studies focus on understanding what goes on in natural settings as teachers are confronted with new policies, programs or practices. These kinds of studies are helpful because they provide theoretical frameworks to guide the interpretation of data and future design efforts; they also provide insights into the complex nature of the authentic task of improving teaching in natural environments.

Designing Policies for Large Scale Teacher Learning

Another approach to connecting policy and the learning sciences builds on the long tradition of design in the learning sciences. It involves the co-design of district and state policies that guide the development of environments that support large-scale learning (Cobb & Jackson, 2012; Penuel & Spillane, 2014). This approach not only broadens the

target of design beyond students to include teachers (and other education professionals such as instructional coaches, school leaders, and even policy makers themselves), but also broadens the targets of design to include the school, district and state policy environments that form the contexts of teacher learning. As noted earlier, several researchers have begun to use "design-based *implementation* research," an approach in which, unlike the arms-length research described above, researchers and practitioners jointly create research questions, design interventions, and consider evidence at the larger scales of districts and systems (McKenney, this volume; Penuel et al, 2011).

Here we argue that design-based implementation research will be most robust when it has its roots in what we know about learning. In this section, we provide three examples of large-scale, design-based change, examples that we admittedly are familiar with because of our participation in or examination of them. The first two examples offer alternative ways to conceptualize alignment, a construct frequently evoked by policy makers and researchers.

Example 1:Professional learning rooted in goals for student learning. An illustration of how learning requirements for students can guide the design of policies for teacher learning comes from Community School District #2 in New York City (Elmore & Burney, 1999; Fink & Resnick, 2001; Stein & D'Amico, 2002a). District #2 adopted the Balanced Literacy program (Fountas & Pinnell, 2001) as their official elementary curriculum in 19xx. Based on a Vygotskian theory of how children learn to read, this program recommends that students interact authentically with texts at varying levels of challenge in a variety of settings—whole class, small group, and independently—every day. These settings translate loosely into reading *to*, reading *with*, and reading *by* the

student respectively, each of which offers differential amounts of reading challenge and support.

The intellectually ambitious and student-centered nature of the Balanced Literacy Program dictated not only the design of content for district-wide professional development but also the design of the kind of learning experiences designed for teachers. Unlike instructional programs that consist of scripted routines that can be taught in a one-time workshop, the kinds of proficiencies needed to enact the Balanced Literacy Program called for teacher learning that—similar to how student learn to read—is long-term, experientially based, and heavily dependent on interactions with others. In addition to introductory workshops, district leaders designed an array of learning environments for teachers including visitations between teachers at different levels of experience and expertise, school-based staff developers working inside classrooms, after-school teacher study groups, and grade-level teachers groups that discussed student work samples. Teachers' access to these different forms of support was determined based on teachers' needs coupled with leaders' assessment of which form would provide the optimal degree of challenge and support (Stein & D'Amico, 2002b).

Thus, in District #2, the design of learning environments for teachers had its roots in district goals for *what* and *how* students should learn. The nature of the desired interactions between teachers and students inside classrooms sent ripples throughout the system in terms of what needed to be learned, by whom, and how. These ripples resulted in alignment that went beyond teaching the right content at the right grade level (as was the case in typical "curriculum mapping" activities during the NCLB era) to an alignment based on how people learn: In both cases learning was viewed as occurring through

engagement with authentic tasks, by interacting with more capable others, and by participating in a community of individuals who share common goals and values (Stein & D'Amico, 2002a).

District #2 was arguably the first example of an American district that was a supportive environment for the continuous learning of teachers across the entire system (Elmore & Burney, 1999). Here, we argue that it provides an early existence proof that systemic policies can be based on what we know about how students learn.

Example 2: Alignment as a problem of design and a form of learning. Alignment has been a popular construct among policy researchers since the early 1990s (Smith & O'Day, 1990). Policy research defines alignment as the congruence of guidelines and resources across formal hierarchical elements of the system (e.g., state standards, district policy, teacher education, curriculum, assessments) (Smith and O'Day 1990; Porter 1994; Desimone et al. 2002). When misalignments are identified, the logical policy remedy is to strengthen the coherence between and among system components and layers (e.g., more consistent policies at different levels of the system; the development of policies that were more specific, authoritative, powerful, and stable [Porter 1994]). This approach was silent, however, with respect to the kinds of professional engagement within and across various elements of the system that might lead to better or worse kinds of alignment, that is, brittle forms of compliance versus implementation based on teacher understanding of the principles underlying the policy.

A learning perspective on the design of aligned systems, on the other hand, would view efforts aimed at large-scale improvement, as a problem of design. How can a district design environments that foster roughly similar forms of learning across

thousands of professionals--professionals who belong to diverse communities of practice. Often leaders do this by creating reifications that are shared with the diverse communities. When reifications traverse multiple communities, they act as *boundary objects* (e.g., pacing guidelines produced by a district central office that are then passed along to coaches who, in turn, introduce them to teachers). Because the guidelines are meant to be used by multiple communities of practices and sit at the nexus of perspectives, they—as do all boundary objects—have the *potential* to coordinate perspectives and spur similar forms of learning across multiple communities (Star & Griesemer, 1989).

In this view, the work of alignment involves "boundary spanning" among multiple communities; as such it relies not only on boundary objects but also on brokers (individuals who use their memberships in multiple communities to carry practices between them) and boundary practices (regular, on-going forums for mutual engagement for individuals from different communities, the purpose of which is to sustain a connection across boundaries). Just as opportunities to learn *within* communities of practice are created by the interplay of reifications and participation, so, too, opportunities to learn *across* communities of practice are created by the interplay of boundary objects (reifications) and brokers and boundary practices (forms of participation).

Problems associated with implementation of district-wide initiatives frequently occur when teachers are expected to learn in ways that rely heavily on reification—for example, when teachers encounter policy solely in the form of boundary objects such as a new curriculum. Reifications alone, while efficient for reaching large numbers of people,

have limited effectiveness in coordinating meanings because there is not enough overlapping experience between the communities that created the reification and the community that encountered it to create a "coordinated, relevant, or generative meaning" (Wenger 1998, p. 65). In cases of insufficient participation, teachers' relations to the broader enterprise are often literal and procedural; alignment centers on compliance rather than participation in meaning making (Stein & Coburn, 2008).

The intentional balancing of participation and reification represents a different strategy for alignment than that used in policy, one that devotes as much attention to who participates and in what ways as to the design of boundary objects. As such we argue that it is an example of an approach that could be used by learning sciences researchers who are working with district policy makers. It would serve to keep leaders' and researchers' efforts focused on the learning processes that are being set into motion and the extent to which they are producing compliance or a genuine connection to the organization's broader efforts through mutual engagement and the investment of energy to achieve the organization's goals.

Example 3: Designing at the state level. Federal and state policies associated with NCLB and the Common Core State Standards have thrust state departments of education into the position of managing large-scale instructional improvement, a task for which most lack the know-how and organizational capacity to accomplish (Kober & Rentner, 2011). This lack of capacity, we argue, represents another opening for the learning sciences to join with policy, this time by working alongside state leaders to design policies and learning environments based on what we know about how people learn.

An example comes from the state of Tennessee. Tennessee was selected as one of

only two states to receive funding in the first round of President Obama 's Race-to-the-Top initiative. Having adopted the Common Core State Standards and an aligned assessment, state policy makers reached out to an array of intermediaries to assist them in training teachers to develop instructional practices aligned with the Common Core. One such intermediary was the Institute for Learning[1] at the University of Pittsburgh's Learning Research and Development Center. Located within a university-based center devoted to the study of learning, one of the hallmarks of IFL's work is the infusion of research on learning into tools for working educators (Ikemoto & Honig, 2010).

This work is being extended by a new partnership between the Tennessee State Department of Education, the Institute for Learning, and LRDC-based researchers, under the leadership of Jennifer Russell. This three-year, three-way partnership was funded in 2014 by the Institute of Education Sciences under a new competition (Continuous Improvement Research in Education) aimed at making research more responsive to problems of practice. LRDC researchers, IFL fellows and state leaders are in the process of co-designing and building a network of instructional mathematics coaches that will, in turn, work with teachers throughout the state. The work involves specification of a coach-training model that will be iteratively improved through cycles of data collection and model refinement. By examining how and under what conditions enactment of the model produces substantive improvement in teachers' practice, the goal is to produce a model that can be used to guide the implementation of coaching programs in diverse contexts within the state of Tennessee and beyond.

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[1] Since its inception in 1995, the IFL has worked at scale, primarily with large urban districts. One of the IFL's key goals is to build coherence throughout an entire system by co-designing learning-based policies with district leaders and then delivering professional development, and increasingly curriculum and assessments, that are aligned with principles derived from research in the cognitive and social sciences.

Underlying the work is a theory of change that rests on what we know about how people learn. First, the initial model was based on IFL's research-based, content-focused coaching program coupled with additional IFL research-based tools that specify and scaffold (a) *coach* uptake of coaching practices (e.g., a discussion protocol for guiding coach/teacher discussions, video examples of coaching sessions); and (b) *teacher* uptake of CCSM-aligned instruction (e.g., lesson guides for CCSSM-aligned tasks, frameworks for identifying a mathematical task's level of cognitive demand).

Second, the overall work of the partnership is rooted in research on learning, the basic idea being that improving student learning requires learning opportunities for actors at multiple levels of the system (Resnick & Spillane, 2006). At the level of coach training, for example, the model explicates a theory of how teachers learn to become coaches that includes not only the to-be-learned content but also the *processes of learning* that take coaches-in-training from novice to expert performance.

With this project, Tennessee policy leaders are testing out and developing new ways to think about how a state department of education can gain traction on the difficult problem of instructional improvement. As they do so side-by-side with learning-based researchers and research-inspired trainers, they are also—either explicitly or implicitly— learning to use what is known about how people learn in their policy decisions.

CONCLUSION

The overarching goal of education policy in the early part of the 21st century is to improve the learning and performance of all students. Yet, policy makers possess only blunt instruments for achieving this goal: as noted in the introduction, they can demand (*mandate*), reward or sanction (issue *incentives*), invest in *capacity building*, or *change*

systems of authority. The choice of policy instrument (or combination of instruments) is important, we argue, because they signal policy makers' definition of the problem and their beliefs about how to solve it.

We argue that policy makers should make greater use of the policy instrument of *capacity building*. Doing so would signal that they understand the depth of the challenges facing schools today and the steepness of the learning curve that solving those challenges represents. With this reframing of the problem to one of professional learning, the nature of viable solutions changes, too. Instead of *incentivizing* teachers to teach better, policymakers need to figure out how to help them to teach better. Instead of *mandating* principals to evaluate teachers, policymakers need to figure out how to help them create school cultures that support the development of teachers. Instead of changing who has the *authority* to run schools (as is the case when policymakers turn to market-based reforms such as charter schools), policy makers need to redesign schools according to principles based in the learning sciences.

A strong connection between policy, policy research and the learning sciences will require interdisciplinary collaborations focused on problems of practice at scale. The learning sciences brings strong descriptive and design-based research methodologies, both of which can provide deeper understanding of the dynamics of educational learning environments. Rather than averaging the impacts of intervention across large numbers of subjects, methods in the learning sciences are often tuned specifically to detect variation between learners, change in learners over time, and complex dynamics between learning, teaching, and environment. Thus, rather than producing blunt statements about what works on average, learning scientists seek to explain *why* interventions work, to make iterative

improvements that make them stronger, and to identify unexpected consequences during implementation that could undermine interventions. All of this is critically useful for policy makers who are interested in, not just testing existing interventions, but also designing the next generation of educational experiments at scale.

Finally, the realization of a new alliance between policy and the learning sciences will depend on researchers / practitioners / policy makers who are committed to the continuous study of how people learn, and to the ongoing enterprise of designing environments to support that learning at all levels of scale. Connecting research and practice in this way is not trivial; policy makers, researchers, and practitioners come from different fields where the training, knowledge bases, professional discourses, expectations, and rewards are quite different. Collaborating across these differences is challenging and requires all parties to move out of their comfort zones and into trusting, collaborative partnerships where goals, activities, assessment of success, and assignment of credit are negotiated, sometimes on an ongoing basis (Coburn & Stein, 2010; Nelson, London, & Strobel, 2015; Penuel, et al, 2011). The long term potential of the policy/learning sciences alliance may rest on the continued emergence of university-based learning sciences researchers who are trained, hired, and promoted according to criteria that maximize success in research/practice collaborations. A positive development in that regard is the emergence of interdisciplinary Ph.D. training programs that explicitly bring learning, instruction, and policy together and focus on producing researchers who know how to work as part of research/practice collaborations.

In closing, we have made the case that ambitious forms of teaching and learning will not take hold in America unless we abandon the associationist assumptions that

currently undergird our educational system and replace them with learning sciences-based

findings about how people learn. This will require problematizing education and policy in

ways that allow learning scientists to see their own research expertise as relevant for

implementation of educational reform; interdisciplinary collaborations focused on

problems of practice at scale; and field-building and training programs that create a next

generation of learning scientists who are skilled at research/practice collaboration and are

committed to design studies that result in sustainable educational change. The challenges

that we face as a nation, as well as the collective capacity represented by the joining of our

communities, suggest that time is right for laying the seeds for this new alliance.

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