# Ruminations on Reinventing an R&D Capacity for Educational Improvement

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**Setting the Context**

School improvement efforts have typically focused attention on particular instructional practices and school activities. There have been efforts, for example, to develop more rigorous math and science curricula, better mechanisms for integrating students from different ethnic and cultural backgrounds, better strategies for meeting the educational needs of English language learners, more rigorous academic courses for all high school students, and so on. But throughout all of this, the basic institutional structure of schooling was never questioned as it is today. Now, everything is "up for grabs", from the design of new curriculum, to who teaches, to how individuals are prepared, enter the field of teaching and are rewarded for their work, to even who actually gets to run schools.

At base here, a combination of economic, social and technological changes now challenge the historic foundation of the "One Best System" of public education.[1] Educators are under tremendous pressure to help *all* students achieve at high levels. What historically we have asked for only a modest portion of students has now become a universal goal. This goal is especially ambitious given increased immigration, including many students with limited English proficiency. The changing demography of many school systems, especially in urban areas, poses enormous challenges for the existing teaching force. And then there is the whale of technology, which has changed virtually every workplace except schools and represents still another profound challenge ahead.

In other sectors of society, leaders confronting such challenges would turn to their research and development (R&D) communities for guidance. Put succinctly, it is inconceivable that we can respond effectively to the demands for much better schools

without also a serious transformation in the ways we develop and support school professionals, the tools, materials, ideas and evidence with which they work and the instructional opportunities that we afford students for learning. Unfortunately, the current R&D infrastructure for school improvement is weak and fragmented. As I elaborate below, the core institutional arrangements of public education, the work of universities, the commercial sector and the connections among these enterprises combine to form a market failure for educational innovation. All of this exists in turn within a political environment that presses for quick fixes at improving our schools rather than investing in the long term work, including the necessary R&D capacity to advance instructional productivity at scale.

**A Capsule Analysis of the Current State of Affairs of Educational R&D**

First and most obviously, education research is poorly funded. In fields such as medicine and engineering, spending for research amounts to about 5 to 15 percent of total expenditures, with about 20 percent of R&D expenditures going to basic research and about 80 percent to design and systematic development.[2] In contrast, even though education is a 500 billion dollar a year enterprise, we spend well less than a billion dollars a year on educational R&D, or less than a quarter of one percent of the overall education budget.[3]

Second, most education research is conducted in university settings, where new theory development is more valued than practical solutions to real problems. Faculty members are rewarded for their individual scholarly contributions with the singly authored paper in a refereed journal considered the prize accomplishment. Not withstanding a renewed rhetoric in research universities around multi-disciplinary

studies, their institutional culture and incentive structure is not conducive to the long-term collaborative work required to produce practical educational innovations useful to schools.[4] Ironically, important new knowledge is being generated across the social sciences that has salience and *could have* significant effects on improving schooling were this practical task viewed as central to the work of universities. To the point, we have more useable knowledge than ever, but little capacity to exploit it systematically.

Third, while considerable wisdom of practice is surely developed by educational practitioners through their daily work, there are no extant mechanisms to test, refine and transform this practitioner knowledge into a professional knowledge base.[5] Moreover, the pre-service preparation and socialization of teachers into the profession is typically devoid of significant exposure to educational statistics, research design, and measurement topics. The teacher education programs and applied research activities within schools of education are often entirely separate enterprises. Not surprisingly then, the research developed in the academy tends to be viewed by practitioners as primarily for other researchers. Under these circumstances, even when relevant research exists, educators and policymakers are just as likely to rely on ideological preferences, customary practice or conventional wisdom to guide their decisions.[6]

Fourth, most school districts operate in a short-term reactive environment vis-à-vis innovation. Absent in most districts is any strategic vision of the core problems of practice that merit their sustained attention. Districts are not pro-active in developing and refining new instructional materials, practices and organizational arrangements based on careful design and development including systematic field trials. Instead, they look to buy tools and quickly implement new services in attempting to respond to new policy

demands. In the process, however, districts often subvert the more ambitious intents of the new policy.[7] Ironically, while school systems rarely have the time and resources to "do it right the first time" they seem to always have the time and money to go back and do it again and again. Chicago's end of social promotion initiative provides a good example of this. The policy was immediately applied district wide, even though extensive prior research had found that simply retaining students in grade often failed to advance their achievement. Subsequent studies by the Consortium on Chicago School Research found that the same proved true in Chicago, even as multiple waves of students were subject to a costly non-effective intervention that "sounded good".[8]

To be sure, there are notable exceptions, such as the literacy initiatives in District 2 in New York and the technology-supported curriculum efforts in Bellevue, Washington. In the New York case, a full literacy instructional system was developed over the course of a decade.[9] Anchored in the practices of comprehensive literacy, the initiative included substantial budget reallocations to fund intensive staff development of teachers and principals working within this framework. A new organizational role of school-based staff developer and new practices to advance teacher learning such as the "professional development lab" were instituted. The role of the principal was transformed to emphasize instructional leadership and the organization teachers' work was reframed as school-based communities of shared practice. A new system of professional accountability was introduced from the classroom to the central office that included school walk through processes and regular use of evidence from practice to inform the continued improvement of practice. In the Bellevue case, a comprehensive and integrated program of curricular development and lesson planning was developed

and refined over time so that even relatively novice teachers might be able to advance high academic attainment for all students. A vibrant technological infrastructure also was put in place to support the enactment of the curriculum and to enable teachers' use of these materials and ability to learn from them. Both of these intensive efforts at school improvement were marked by extraordinary, sustained local leadership coupled with keen professional resources operating in unusually stable political environments. That such successful, sustained design and development efforts remain few in number speaks in volume to the overall institutional R and D infrastructure problem that we now confront.

Fifth, the commercial sector, which plays a powerful role in education practice (through development of textbooks, curriculum materials and teacher professional development programs), is also not a major R&D player. Commercial firms have to sell goods and services to districts and states and they understand the factors, noted above, that shape these purchasing decisions. Not surprisingly, their efforts are primarily influenced by political realities of coping with state and district approval mechanisms.[10] While the press for "evidence-based practices" is encouraging more formal evaluations of commercial products and services, this research continues primarily as an extension of the marketing objectives of the firm. It has not, to date at least, signaled a new commitment to sustained design and engineering of educational innovation.

Sixth, the nature of federal and state funding for school improvement efforts creates distortion effects and adds uncertainty to the overall marketplace. Because virtually no local general fund revenues are used to purchase innovations or support their development, externally provided resources from federal and state sources, as well as

private philanthropy, exert extraordinary leverage here. So for example, we witnessed in the 1990s the growth of efforts such as Success for All (SFA) and Reading Recovery (RR) because program costs could be paid with available discretionary funds. Interestingly, both SFA and RR have strong applied research underpinnings and both organizations support ongoing R&D efforts on their programs. SFA, for example, is involved in a major randomized field trial and the research on RR was recently reviewed and approved as effective by the federal What Works Clearinghouse. Even though in many ways these two entities represent good models of the evidence-based practice to which we aspire, neither has fared well in recent years as federal support and guidance under Reading First shifted state and district attention in other directions. In the process, both organizations have been substantially weakened.

The overall net effect of policy has been to create an unpredictable marketplace for innovation. From the perspective of a social entrepreneur, even if one builds good products, districts may not purchase them for reasons unrelated to product quality or even the improvement problem that these new tools and services may seek to address. This difficulty of selling products and services into districts is well understood by venture capitalists, which quite reasonably depresses their willingness to invest in such undertakings. (For a further discussion on this point see the Keeney and Pianko paper in this volume).[11]

In sum, a complex set of institutional dynamics combine to form an unproductive environment for R&D. Absent substantial and reliable external funding, the risks and market uncertainty for commercial firms are high. School practitioners and school districts who ought to be active players, and send appropriate, stable market signals to

developers, have little incentive to do so. Finally, the expertise and institutional resources of the academy tends to be misaligned with the needs of sustained improvement. While it is relatively easy to sum up the problems, crafting a productive response is considerably more demanding.

**A New Vision: Problem-Centered Design, Engineering and Development (D-E-D) for Educational Improvement**

Observations such as these have led to a growing recognition that a new R&D infrastructure is needed to support school improvement in the U.S. Although the analyses of the problems differ somewhat and proposals vary, there is broad agreement that such an infrastructure should focus on pressing problems of practice in school settings, aim to find solutions for these problems, contribute to a gradually expanding knowledge base about improving schooling and ultimately hold its own work accountable against evidence on enhancing productivity.

A leading statement in this regard was a 1999 report of The National Academy of Education that called for programs of use-inspired research that address broad-based problems critical for educational improvement; where researchers and practitioners work together to frame the problem and its solution; where there is long-term engagement in the refinement of these innovations; and where this is complemented with a commitment to general knowledge development about how and why things work (or do not).

This report in turn inspired a 2003 National Academy of Sciences (NAS) study calling for a new genre of problem-centered R&D. As the NAS authors noted:

> There is currently no institution in which education practitioners and researchers from a variety of disciplines are provided with support to interact, collaborate, and learn from each other. Thus, researchers often fail to bring important understandings to the stage of usability, and

> practitioners have no way either to analyze and systematize their own wisdom of practice or to influence the directions and shape of the research agenda. (SERP, 2003, p. 2)

This proposal for a Strategic Educational Research Program (SERP) has given rise to an initial round of efforts in Boston, San Francisco and other locations to bridge the academic research-practitioner gap, with new forms of collaborative district-based R&D. In its original vision, SERP sought to create a new independent institution, supported by private philanthropy and a federation of states, to carry out and direct an ambitious R&D agenda.

More recently, Chris Whittle, the founder of the Edison Schools, has proposed a major new federal investment in R&D.[12] Whittle envisions the commercial sector as taking a lead role in seeking, nurturing and inspiring educational breakthroughs. He argues for substantially expanded funding for new school designs, better strategies for developing teachers and principals, and targeted efforts around "critical instructional components" such as new science programs. Whittle envisions that much of this R&D would occur through federal contracting with private firms and argues that federal funding should rise to four billion dollars a year to vitalize all of this.

Along a similar line, but taking a different tack, has been a response by the Learning Federation (a group composed primarily of learning scientists) working in partnership with the Federation of American Scientists (FAS). This group has argued for a major new federal R&D investment to support the development of information technology that might transform education both in the home and workplace. Their emphasis is on long-term initiatives that might fundamentally reshape learning and schooling. They look to build productive partnerships among learning scientists and

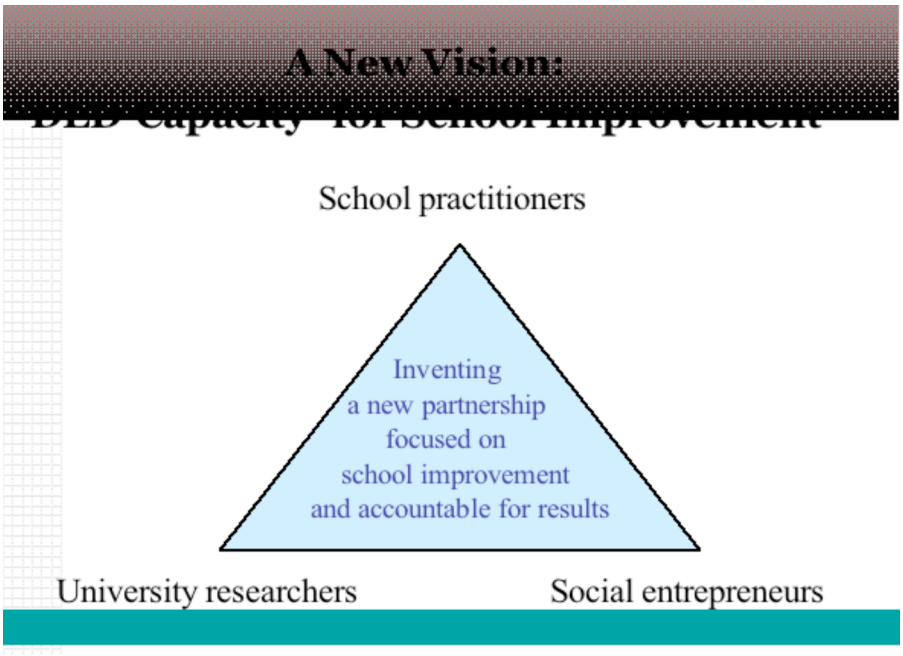
industry as the key mechanism to advance these goals. Of note, both Whittle and FAS argue for a new institutional platform, akin to either Defense Advanced Research Projects Agency (DARPA) or National Institutes of Health (NIH), to operate and oversee such activity.

Although each report brings a somewhat different perspective to the problem, there is a growing consensus that a major new investment in R&D is needed to support school improvement in the U.S. Also of note, no one appears to argue that simply putting more money into existing institutions is likely to solve this problem. Rather, a new infrastructure is required, building its agenda around the core problems of practice improvement rather than isolated academic theories or currently popular, but ungrounded, policy ideas. Productive innovations need to be co-developed by researchers and practitioners, tried out in schools, refined and retried. Such work entails an engineering orientation where the varied demands and details of local contexts are a direct object of study and design, rather than being decried as a "failure to implement properly". Finally, in various ways, most proposals also envision new mechanisms to draw in the commercial sector as a partner during the actual R&D, not just at the "end of the chain". These firms can bring significant technical resources and practical perspective to the table during early stages of R&D. They in turn can learn valuable lessons through partnering in this work that they might use in a variety of ways, and also build along the way their own capabilities to support more productive school use of the fruits from this R & D.

In sum, we need to catalyze and nurture a new design-engineering-development (D-E-D) enterprise around schooling.[13] While significant individual capabilities exist that can be drawn upon, no extant institution can amass and mobilize the needed talent

and develop the necessary "know how" to make this all come together. The academy and expert practitioners are very good at identifying problems of practice and documenting how problems of practice look in the context of day-to-day work. Commercial actors, on the other hand, have very good mechanisms for creating technical applications that are robust and useable. Past failures to blend effectively these diverse forms of expertise have yielded research insights that fail to make effective products. Future D-E-D must engage in more direct partnerships among schools, the academy and commercial firms to advance a more effective educational R&D enterprise. Figure 1 captures the spirit of these new collaborative forms.[14]

**Figure 1: A New Domain of Work: Design, Engineering and Development to Advance School Improvement**



**Some Observations toward Developing a Robust D-E-D Infrastructure to Improve School Practice**

While sweeping proposals of the sort outlined above are the meat and potatoes of special panels and committees, the successful launch of such an effort will depend on both visionary leadership and thoughtful institutional design. The remainder of this paper focuses on some key considerations in this regard and outlines some plausible courses of action. These observations draw heavily on our experiences over the last six years as collaborators in the Information Infrastructure System (IIS) Group. The IIS group has drawn together diverse academic colleagues with strong educational practitioners and select social entrepreneurs who seek to bring the resources of their commercial ventures to bear on improving schooling in disadvantaged urban contexts. Specifically, we ask: How might a combination of technology and new social practices guide classrooms and schools toward more ambitious instruction for every student?[15] This orienting problem has led us to develop a formative assessment and data visualization system for primary literacy, work on a web-based multi-media environment to support professional learning in comprehensive literacy (including now a multi-site trial of its effectiveness), a clinical case management system to support operations of the diverse academic, social, psychological, health and mental programs typically extant in disadvantaged urban schools, and an increasing array of technology-based tools that both students and teachers use in their day-to-day school literacy activities. The comments offered below draw heavily on the lessons learned in the conduct of this work, as well as more general observations from efforts over the last half-century at seeking to bring applied research to bear on school improvement.

**The Varied Nature of Educational Innovations**

First, we need to unpack our operating assumptions about the nature of educational innovations. Some innovations are relatively "simple". As a result, they can easily be implemented and can scale very quickly. An example has been the recent introduction of 10 week benchmark assessment systems in many school districts across the country. These tests are designed to track closely with the end-of-year state accountability tests. Administered periodically throughout the academic year, test results are fed back quickly to schools and are typically used both to modify instruction (for example, re-teaching lessons where children failed to achieve mastery) and to manage an accountability triage (for example, identifying the sub-set of students near the accountability targets who can be moved pass the target with some short-term intervention). We have witnessed an expansion of these activities, from almost ground zero a few years ago to now widespread use.

Certain features of the innovation have made this rapid expansion possible. First and most significantly, the innovations themselves require only modest changes in teachers' and schools' existing practices, and make only modest demands on new teacher learning.[16] They are relatively easy to absorb within existing school operations (the time and resource demands are modest) and they do not represent a fundamental challenge to prevailing school norms. Second, the D-E-D activity for such interventions tends to follow a relatively straightforward process (referred to as a "research→practice" model): (1) develop the tool→ ; (2) evaluate efficacy (ideally through a randomized trial design) → ; and (3) implement (or make findings available to practitioners). If one places ample discretionary resources and policy incentives behind such activity—voila—a rapid

change in practice occurs. This is the typical working model assumed by most innovators and in many policy discussions today.[17]

Unfortunately, many educational innovations, especially those aimed at more ambitious outcomes, do not share these characteristics. In general, as reforms become more ambitious—in the sense that they aim at more complex intellectual work for students, require more teacher learning or demand more expert management systems—many more design problems come into play that demand greater and more diverse expertise to solve.

**Framing the Reform Goals for D-E-D**

Embedded in any list of "problems of practice" that might be the focus of D-E-D are basic assumptions about what schools should seek to accomplish. Thus, first and foremost, a new D-E-D infrastructure needs some clarity about the educational goals we aim to advance. For some this means higher standardized test scores, lower drop out rates and increased numbers of students in college. Others argue that while all of this is important, it is just not enough. In a global economy where increasing numbers of students around the world are now achieving 'basic academic skills", the United States must do more if we are to maintain preeminence as a first world economy and sustain our national belief in opportunity for all. Success in a "knowledge economy" within a "conceptual age" poses new demands on students to be able to *apply* basic skills and conceptual knowledge in the analysis of complex problems.[18] It demands more sophisticated social communication skills and the ability to use these effectively in working with others. It entails efficacy in use of a variety of new technologies to support analysis and in deploying multi-media tools to enhance communication and learning.

In truth, no one knows exactly what all of this really means for the future of schooling in America. However, from the point of view of building a vital infrastructure to support educational improvement, whatever direction reform may eventually turn, it seems prudent that we aim high in our R & D efforts as the long-term costs in under-estimating the target are unacceptable. Quite simply, we cannot afford to fail. Thus, in the pages below, we accept as a working hypothesis the implications of a "world is flat" analysis for dramatic changes required in the goals for public education in the United States. We attempt to flesh out some of the implications of this perspective for future educational R&D.

*A Primer on the Organization Groundwork for More Ambitious Instruction*

It is widely argued that instructional reform on a broad scale requires challenging basic routines and organizational norms deeply entrenched in schools. Most reform proponents embrace an imposing set of new expectations for school practice and the organization of schooling that include:

- A reflective teaching practice where day-to-day decision-making is based on regular observations about students' work in the classroom, clear understanding of the appropriate aims for subsequent instruction, and deep content knowledge about how best to affect such learning given the instructional system within which a teacher's work is conducted;
- A teaching practice open to examination by colleagues, organized around a common system for both describing the development of students as learners and the pedagogical options available to teachers in advancing such learning;

- A norm among teachers that the critique of one another's practice is essential to collective improvement and that such commentary about practice improvement does not mean that one is "criticizing the people";
- An ethic that ongoing adult learning to improve practice is a core professional responsibility; and
- An internal school accountability process aimed at continuously improving student learning.

Central to this school transformation is a tightening of the connection between teaching practice, evidence about student learning, the communication and use of this evidence and structured opportunities to learn from all of this. This dynamic must occur in multiple contexts:

- in the work of individual teachers where instructional decision-making is firmly rooted in the day-to-day evidence about student learning;
- in the social learning of a community of school professionals as they plan, engage and learn together about efforts to improve their instruction; and
- in the internal management of an instructional program where principals, staff developers and other school and district-based instructional leaders make critical resource allocation decisions.

In short, moving toward an evidence-base culture requires replacing the traditional loose coupling, characteristic of schools (where teachers work independently behind closed doors, where much of the system level activity bears little relationship to teaching and learning, and where adult political considerations regularly trump concerns for students' educational needs) with more coherent, strategic and coordinated action.

The backbone for all of this is a shared language for teaching, learning and schooling that is made visible within new systems of tools and social practices designed to support such practice transformation.

The efforts discussed early that emerged in literacy instruction within District 2 in New York during the 1990's represent a working example of this at some scale.[19] These reform efforts viewed teaching as a complex task that makes substantial demands on teacher cognition, both in the planning of lessons and "in the moment" when instruction is carried out. This reflective practice was supported by teachers working with common instructional materials, tools, classroom practices (including routines to organize and manage instruction), a shared framework for detailing instructional objectives and common evidence about student learning. This instructional system provided both supports for the development of new teachers entering a school (that is, it did not assumed that each new teacher must develop her craft from scratch), while creating ample ground for more expert teachers to engage in professional activities that advance the collective work of the community. We note that this conception of teaching practice, of working within a professional community anchored in a common instructional system, strikes us as an attractive middle-ground in the classic polarity between "scripting instruction" (where the objective is to standardize teaching around common "scripts") versus the organizing belief that every instructional situation and child is unique and therefore "every individual classroom must be a Leonardo".

*An Intrinsic Dilemma for Reform and D-E-D to Advance It*

Effective educational innovation is not just a technical act of tool design but is also intrinsically a social and political activity. Effective D-E-D entails a deep

understanding of the institutional arrangements of schooling that can (and often have) strongly influence the introduction and take-up of any innovation. While D-E-D may seek to change the way teachers and students work in classrooms, ambitious instructional reforms (like District 2) typically require concomitant changes in the overall organization of schools and the district and state policy frameworks within which they operate. This makes the conduct of D-E-D itself ambitious and challenging in terms of the breadth of expertise needed and the collective capabilities that must be assembled. Moreover, it also means that D-E-D will likely be embedded in the same political dilemmas that confront school reform itself. The more ambitious the goals that we set for reform, the more likely it is that many practitioners will encounter failure at least initially. How to anticipate and analyze such failures and then manage their consequences may well be key to keeping the reforms (and the new tools and practices designed to advance them) on course. [20]

Historically, these problems have lingered in the chasm that exists between research, practice and the commercial sector. Academic researchers build innovations and then decry the failure of commercial firms and districts to support and implement them properly. The latter in turn complain about the lack of attention in the academy to the real world conditions in school districts today. Observations such as these undergird the conclusions offered earlier in this paper that a more effective D-E-D in education will entail inventing a new infrastructure to advance this work. The organizational and political dimensions of reform must have a place at the "design table" along with the practical expertise of principals and teachers, the technical expertise of commercial designers and engineers, and the social-cognitive perspective of learning scientists. Currently, there are few places where such expertise regularly intersects.

*Assembling a Diverse Colleagueship of Expertise*

Ambitious educational innovations require individuals with diverse expertise (academic, clinical and commercial) working collaboratively for sustained periods of time. In our IIS initiative, for example, we formed an academic group consisting of subject-matter experts, learning scientists, technology designers and organizational scientists. This academic expertise in turn has blended with clinical expertise in principals, staff developers, teachers and other professionals whose work we sought to assist. We also joined with commercial firms (Teachscape and Wireless Generation) whose technical resources were central to our R&D efforts and whose field capacity would be essential for subsequent growth of this D-E-D work. Much of the initial design work of rapid prototyping, field trial and redesign (we call this the α phase) has been carried out in North Kenwood Oakland professional development charter school (NKO), established and operated by the Center for Urban School Improvement within the University of Chicago. From its very beginning, NKO was organized to support ongoing R&D to improve practice. Likewise, we built on a decade-long partnership with the Literacy Collaborative and the national network of schools with which they work. Their expertise and large number of affiliated school sites have been an essential resource as IIS has moved into large-scale β phase field trials where issues of robust tool design and building capacity for working at scale have become a central focus.

This type of collaboration in education is difficult to create and sustain because no existing institution provides an especially hospitable home for such boundary-spanning activities. Universities are not particularly well-structured for assembling in-house the academic expertise necessary for such complex problem-solving because the diverse

academic appointments needed must typically be approved by multiple, independent departments or faculty groups. Similarly, absent an established practice of clinical professors and well-defined cooperative agreements with school sites for R&D, building and maintaining productive clinical collaborations can be highly problematic. Then there is the cultural divide between the academy and the commercial sector and the residual distrust that needs to be deconstructed. Without a stronger base of institutional ties, an enormous overhead in time is imposed to secure the people and to continue to nurture the basic work relationships necessary to execute this activity.

In short, a more vital D-E-D infrastructure requires a more hospitable institutional design. The current forms of "partnership" are far too brittle a base on which to build the vision described above. While IIS was able to experience some success in this regard, and others have as well,[21] this work remains fragile. Far too much time and leadership energy is spent on holding the enterprise together (and thereby diverting attention away from the actual work of innovation development to support school improvement).

**Securing Essential Resources to Carry Out DED**

*Sustained, Stable Funding Environment*

A serious D-E-D infrastructure will entail a substantial commitment of new financial resources over sustained periods of time. D-E-D needs regular access to clinical expertise and field sites for prototyping and developing its innovations. Funding must not only provide sustained support for designers, developers and researchers, but also address the demands placed on schools and practitioners who collaborate with them. In particular, as one moves into more complex innovations that make more extensive

demands on individual practitioners and schools, a reasonable mechanism to support and remunerate these efforts need to be developed. Currently, most educational R&D is carried out as an add-on activity alongside regular school work. It depends heavily on the voluntary commitments of teachers and other educational professionals who take on these tasks in addition to their "day jobs". The role of developing professionals and the tools, materials and ideas with which they work imposes additional costs and demands on these organizations. Unlike NKO at USI, few schools are organized and financed to undertake R&D as a regular part of their work. The institutional analogy would be to the teaching hospital which by design is a more expensive operation than a typical community hospital. We need similar organizational innovations in education today.[22]

*Authority to Conduct Research and Development*

The distribution of power between R&D centers and public school systems creates serious challenges for the kinds of innovation that we have been discussing. Carrying out reforms in schools requires that a modicum of authority be vested in R&D teams. Moreover, these needs amplify as the innovations become more expansive in their scope (for example, whole school transformation, school-community partnerships) and where the initial development phase may span multiple years. Normatively, a shared understanding is needed among clinical participants that R&D is a regular part of "what we do here". Currently, R&D efforts must compete for staff time, attention and commitment against many other initiatives from the district, state or teachers' organizations. Since districts generally do not see R&D as their core business, the processes by which one secures the necessary institutional support for this work remain time consuming and idiosyncratic. Moreover, even when productive arrangements have

eventually been put in place, changes in district leadership or state policy can easily derail even longstanding partnerships. In short, extant mechanisms are too cumbersome, slow, and unpredictable to support the vital DED infrastructure envisioned above. It was precisely such concerns that led us to develop our own charter school at the Center for Urban School Improvement to have a more stable and supportive environment for the α level technology development work of IIS. Similarly, charter management organizations could prove to be an effective base for large-scale β level inquires.

*Building Capacity for Innovation Travel*

After innovations have been prototyped successfully and field tested across a number of sites, one might normally think about the next stage as focusing on diffusion at scale. The capabilities required to accomplish this vary as a function of innovation complexity and draw differentially on several key resources for scaling. First, successful scaling requires an *articulation of the core ideas and principles that undergird the innovation*. Inevitably, the innovation is adapted to some degree as it moves out to new sites, and a clear articulation of these core principles is critical to reducing the likelihood of seriously flawed local adaptations. Second are the *new tools, materials, and procedures* that constitute the technical core of the innovation. When well designed, the core principles that undergird the innovation are highly visible in this technology layer. As a result, use of these tools, materials, and procedures provide multiple opportunities to come to understand better the core principles as well. Third, effective diffusion for some innovations also requires *developing expert human resources*. More complex, innovations travel through individuals who have already developed expertise in this domain and can help guide its acquisition by others. Key here is a generalization from

learning science that guided apprenticeship, rather than following directions in some "how to guide", is key to acquiring complex skills (Orr 1996). Fourth, many innovations are themselves dynamic entities and need to develop and maintain *social networks* that support their continued evolution and distribution.

With "simple" innovations, such as the benchmark assessment systems described earlier, knowledge about the innovation is largely carried in tools, materials and procedures. Because these elements have been subjected to practical testing and refinement over time and across many contexts, fidelity in their implementation is important. Such reforms make fewer demands on human resources and social network development. As a result, they may travel with relative ease.

In contrast, more complex innovations, such as the District 2 literacy initiative, are only partially defined through tool, material and procedural specification. Their effective travel from one site to another draws significantly on the other resources discussed above. To the point, innovation diffusion in these situations is contingent on the available number of individuals, and networks of individuals, who have already established expertise in this domain.[23] In short, the maximum rate of travel at any given time depends on the current density of this expertise network surrounding the innovation.[24] Moreover, since acquiring expertise in an ambitious instructional initiative may take several years, this further limits how rapidly such an innovation can spread.

This view about innovation complexity also necessitates some rethinking of traditional notions about "implementing programs with fidelity". The traditional conception of fidelity, assumes a delivery standard to which local agents can be held accountable by external agents (for example, program managers), who are readily able to

characterize local agents' observable behavior as consistent or inconsistent with the innovation. While this view may work adequately with artifact-centric innovations (for example, the introduction of 10 week multiple choice benchmark assessments), more complex innovations, as noted above, make substantial demands on individual and organization-wide learning and change. These are better conceived as problems of expertise development rather than fidelity implementation.[25]

For instance, our IIS group is developing a multi-media resource base and social network tools to enhance professional development in comprehensive literacy. This group is in the process of field testing and validating a Developing Language and Literacy Teaching (DLLT) observation system for charting teacher practice improvement. [26] Within the DLLT, procedural fidelity in enacting various instructional components represents only a first stage in teachers' development toward pedagogic expertise. The high end of the spectrum focuses on teachers' in-class decision-making, how it draws on evidence of students' development as readers and writers and orchestrates strategic use of the instructional resources and pedagogic strategies offered within a comprehensive literacy framework to advance subsequent student learning.

At base here then is another critical implication for a more effective D-E-D infrastructure. An important part of innovation development entails building human capabilities and organizational capacity to support the diffusion of the innovation itself. This entails a more organic conception of travel than simply "build effective tools and then market them".

*More Supportive Policy Conditions*

Improving the R&D infrastructure also requires that we focus some attention on the "demand side" for innovation among schools and districts. This demand depends in significant ways on public policy and the larger political environment in which schools operate. Sizeable public resources must be captured for innovations to go to scale. Districts will not typically engage in major reallocations of general education funds for this purpose, since their spending is highly constrained by statute, collective bargaining agreements and community expectations. Some innovations, such as the purchase of a new text book series, can be accomplished within these constraints. In contrast, more ambitious innovations, even those with documented effectiveness, may not be adopted unless new resources are specifically targeted for these purposes.

Federal efforts over the last several years to use financial incentives and more generally the persuasive power of government (that is, the "bully pulpit") to press on school districts to become more results-driven represent a constructive development in this regard. Even so, we should not underestimate the efforts entailed in making such changes in the structure and operating norms of schools and districts. Absent further new funding mechanisms that directly target the development and take-up of innovations, D-E-D may well produce good products but still have to confront the troublesome question, "If we build it, will they really come?"[27]

**Framing a D-E-D Agenda[28]**

Effective D-E-D must take its roots in a deep understanding of the day-to-day problems of practice in ordinary schools trying to advance more ambitious teaching and learning for every child. A critical act for D-E-D involves identifying the "high leverage

problems" embedded in this day-to-day work. Essentially this is a "value-added question": "How and where might introducing new tools and social practices advance the work of teachers and other school professionals in improving student engagement and learning?"

A core consideration in this regard involves working on problems that come from practice rather than the problems that we wished practitioners had. This distinction, however, does not reduce simply to asking practitioners what problems they want fixed. D-E-D must also focus on problematizing practice (that is, identifying taken-for-granted aspects of schooling that may need to be challenged if meaningful improvements in student learning are to occur). For example, it was generally taken for granted in Chicago schools that supplemental academic, social and psychological supplemental services often did not work well for children and their families. No one, however seemed to own the underlying problem of how to manage more effectively this vast and highly fragmented array of support activities. The IIS group identified this as a high leverage problem and sought to engage school practitioners in understanding the underlying problem and then developing new tools and social practices that might assist this work.

In short, an ongoing dialogue needs to be established between the critical perspective that academics may bring to practice and the day-to-day problems as understood by practitioners. Moreover, undergirding all of this is one large orienting concern for D-E-D: Can we make schooling *more efficient* while simultaneously pressing forward toward *more ambitious academic learning* for all children?

**Managing a Likely Tension**

If a significant D-E-D effort emerges in education, it will quickly confront its own resource allocation problem—that is, where should we focus our attention?

*Improving Schooling: Working within the Horizon of Current Practice*

This perspective takes a shorter time view (perhaps a five year time frame) and focuses attention on changes in the current operations of schools that might affect significant increases in students' basic skills learning. For example, we are now in a period of major change in the professional workforce as many new teachers are being hired. Anything that D-E-D could do to advance their initial entry into teaching and enhance the quality of their early professional learning should have a direct payoff for students. So one likely "low hanging fruit" would be to focus on enhancing supports for teacher learning and the management of such learning systems. Some possible places to invest might include:

- *New designs that integrate pre-service, induction, and ongoing professional development aiming to alter the productivity of new teachers and retaining the best of them in the profession.* The residency program in the Boston Public Schools represents one example of such a venture. This novel program in new teacher development places apprenticeship in clinical practice at the heart of teacher preparation, brings master teachers into this work in a central rather than auxiliary capacity and focuses attention on how schools must be redesigned to support the entry of new members into teaching. Deeply understanding the operations of such a program, systematically evaluating its effectiveness and

learning how to accomplish efforts like this at scale could be one important DED focus;

- *Developing hybrid face-to-face and web-based environments to support teacher learning and professional community formation.* Such strategies can make more efficient use of professional time by reducing the amount of travel needed and may even enhance the efficacy of coaching activity. For example, Doug Powell and colleagues at Purdue are experimenting with coaching support for Head Start whereby teachers send videos of their own teaching to a coaching center, and a personal coach at the center reviews the video and sends back detailed commentary and suggestions. Rather than spending several hours a day in commuting out to Head Start sites, coaches can now spend more time on analysis and formative feedback to teachers. Moreover, emerging findings suggests that there are reasons to posit that professional feedback provided in this manner could ultimately be more effective.
- *Taking on the core questions in adult learning: "What is it that we want teachers to know, and how can we assure that they know it?"* Explicating clear measurable standards here is key to building a professional performance assessment system. The DLLT observation system described above is an example of such instrumentation. It is anchored in careful specification of the specific instructional competency expected of teachers (for example, what does guided reading or a writers' workshop look like when well done, and how do we know if this is actually occurring?) coupled with rigorous scientific study of its reliability and validity. Absent developments such as this, districts will continue to make

significant human resource investments without any micro-level data systems to inform the continued development of these professional education programs.[29]

*Reinventing Education: Looking at and Beyond the Horizon*

A contrasting perspective for a D-E-D agenda would focus on more fundamental, longer term changes in the basic organization and conduct of schooling. In the near future, all students will likely live in a ubiquitous 24/7 digital environment. How can this extraordinary new capacity transform learning for adults and students alike? Can we use this, for example, to break out of the "egg crate" structure of schooling where a teacher and a classroom of 20 to 30 students is considered the only way to organize instruction. Might we envision ways in which technology might enable more dynamic, flexible and individualized environments for this activity? What might the "new literacies" in multi-media education for a global economy actually look like and how might we accomplish this at scale? Can the engaging aspect of gaming be harnessed as a tool for advancing more traditional forms of academic learning as well? These are just a few examples of the kinds of problems of practice that might anchor a "beyond the horizons" agenda. While D-E-D on such questions would not likely move the bottom line on test scores right away, such efforts could eventually transform the overall technology of schooling.[30]

**The Social Organization of D-E-D**

We have already described how Design-Engineering and Development activity might be structured as a three-legged institutional stool where academic expertise engages in participatory design with clinical and commercial partners. Each sector—the academic, clinical and commercial—bring distinctive resources and expertise, and a more effective melding of these resources is key to taking innovations to scale.

In addition, two other core elements are needed to frame a viable social organization:

- an evolving theory of school practice improvement to guide action within this colleagueship of expertise; and
- a work organization that recognizes the distinctive multiple demands entailed in moving from rapid small-scale prototyping through larger efficacy studies to efforts aimed at continued learning.

*Grounded in a Working Theory of Practice Improvement*[31]

While diversity of backgrounds and expertise are an essential resource for D-E-D, this can also create its own tensions. Lacking a common language for conceptualizing the problems embedded in school practice and for thinking about effective innovation design can quickly create a tower of Babel within a D-E-D group.

The activity framework summarized below was created in the context of our IIS group to address precisely this problem. The framework has proven valuable for two reasons. First, it focuses on day-to-day school activity and efforts to change this activity. In this regard it constantly presses on the "clinical validity" of our efforts. Specifically, it offers a viable frame for conceptualizing key problems in school practice where new technologies and social practices might well add value. Second, from an academic perspective, it provides a language in which the efforts of learning scientists thinking about problems of cognition and motivation along with technologists thinking about the design of new tools might constructively join with organizational sociologists thinking about problems of innovation diffusion.[32]

Our framework is organized around four key observations:

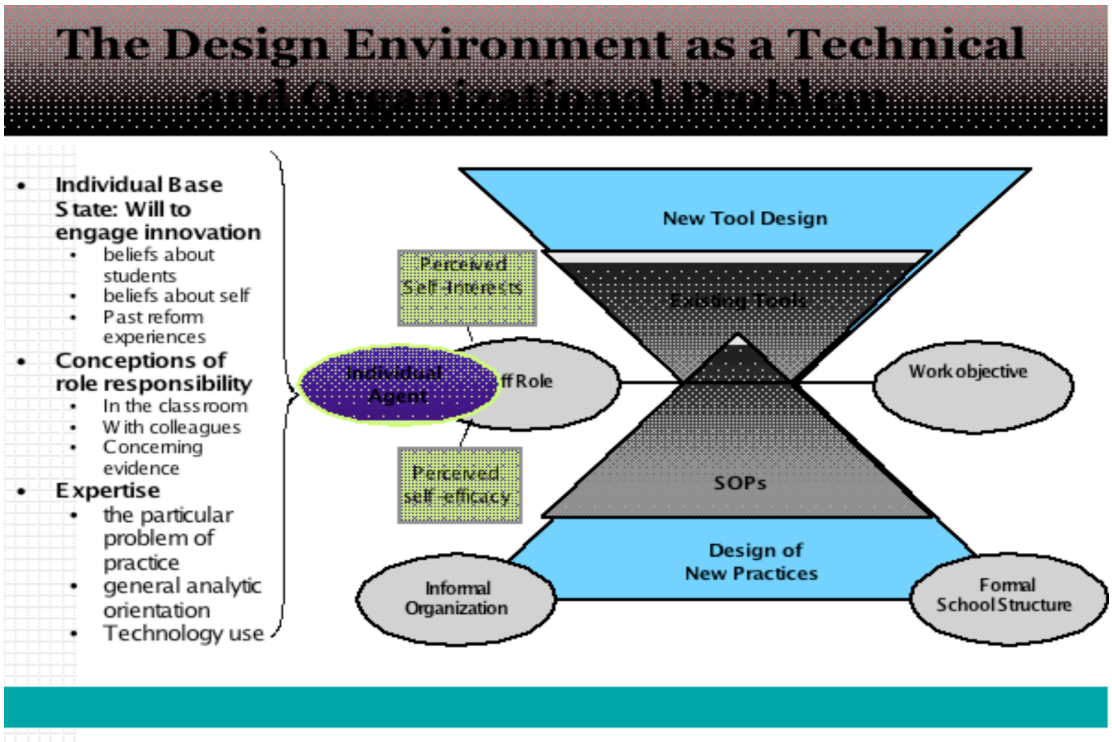
- a deep understanding of specific school practices and the intentional activity that each represents;
- a recognition of the different knowledge, skills and dispositions that individual staff bring to these practices and the demands that this variation places on the design of a new innovation;
- an appreciation of how adult and student work in schools is shaped by local context and larger institutional features; and
- the effective mechanisms available to external agents to catalyze the take-up, use and diffusion of innovations within schools and across districts.

School practice is broken down into work activity segments. Each activity segment represents some specific work problem embedded in some individual roles within a school. For instance, primary school teachers regularly group and regroup students for reading instruction. They use some tools to assist in this activity and carry it out in accord with certain standard operating procedures within the school. This process could be as simple as each teacher using her informal observations (the tool) to inform assigning students to a group as she thinks best (the standard operating procedure of relying on individual teacher judgment). In contrast, in a more specified instructional system such as Success for All, standard benchmark assessments are administered every five weeks (the tool) and explicit guidance is afforded as to how to use these data for regrouping students (that is, a more bureaucratic standard operating procedure governs this process). In general, D-E-D would focus on specific work activity segments of this

sort and ask how this work might be more effectively mediated by introducing new technologies.

It is important also to recognize that differential individuals bring their own ensemble of beliefs, role conceptions and expertise to their work. The perceived self-interests and competencies of these individuals influence how any new innovation enters the school and shapes whether and how engagement occurs. Moreover, this individual agency can operate quite differently depending on the particularities of school context. Structural features such as leadership priorities, availability of discretionary resources (time and money) and the nature of the prevailing accountability system are obvious factors.[33] Similarly the opinions of informal leaders within the school and the basic work norms among faculty are significant as well.[34] These structural and normative organizational features undergird the base state standard operating procedures (SOPS), and play a key role in whether an innovation may successfully enter a school and influence its pattern of local adaptation.[35]

**Figure 2: Design as a Technical Act of Developing New Tools and Social Practices**



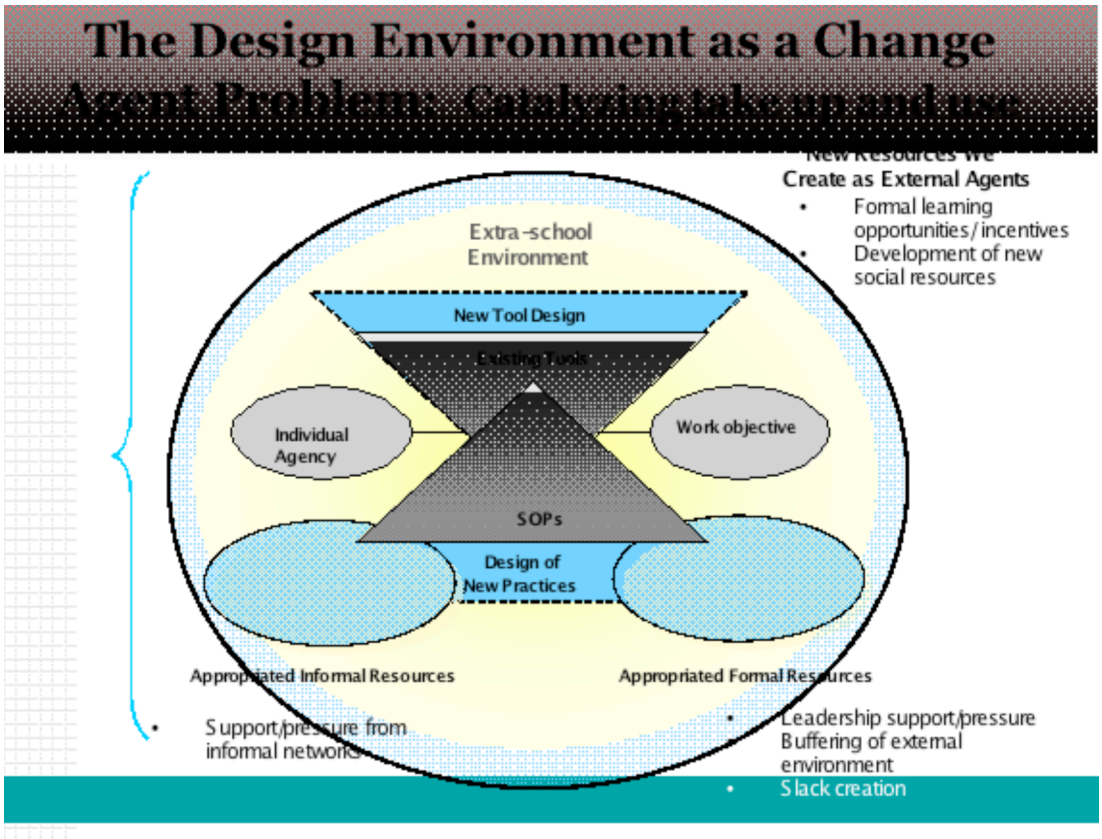

In short, this framing suggests that any efforts to design new tools and social practices for school improvement must be anchored in specific work problems engaged by particular individuals who work within a school organization. Each element represents a potentially critical consideration in D-E-D work. To the point, an inadequate accounting for any one of these elements in the process of innovation design could precipitate failure. Figure 2 represents our attempts to characterize these interrelationships.

Going one step further, in addition to good tool and social practice design, effective D-E-D also requires consideration to how best to support the significant individual and organizational learning that the take up of these tools and practices may entailed. In this regard, as highlighted in Figure 3, one also must attend to: 1) the extant resources and mechanisms that can, and often must, be appropriated within a school's

ecology to catalyze the introduction of innovations; and 2) any new resources that must be deliberately developed to support this take-up, learning and use.

The extant resources on which D-E-D draw include the "will and skill" of formal and informal leaders who can exert pressure to champion the innovation and accelerate its internal diffusion. It also includes the strategic efforts by principals and other leaders to buffer the innovation and create the necessary slack for agent experimentation and learning. Complementing these activities to capture and focus extant internal resources, D-E-D programs may also need to design structured opportunities to support agent learning and deliberately nurture their relationships with individual school actors to form new social resources for local improvement. Taken together with the more technical aspects of design, these considerations constitute the active zone for D-E-D efforts. These are signified in Figure 3 as "working in the blue zone".

**Figure 3: Design from the Perspective of a Change Agent Problem**




Finally, one needs a framework for conceptualizing the types of outcomes that might accrue. Broadly, these fall into three categories: 1) **activity level outcomes** relevant to each specific work problem which we seek to mediate with new tools and social practices. For example and most basic, do teachers use the new procedure? Do they find it helpful? Has any increased efficiency been realized? Is there any evidence of change in professional activity and student learning? 2) **individual level outcomes** where the aspects of individual agents, which influence their initial engagements with an innovation, may in turn be reshaped as these activity cycles proceed over time. For example, if the innovation requires use of some new technology, do teachers gradually come to feel more comfortable with use of technology generally in their work?) and 3)

**organizational level outcomes** which are also often the deep long term target of reform. For example, current reforms often aim toward a more tightly coupled professional environment characterized by a shared language about the technical core, enhanced communication across the organization, and greater reliance and use of information in instructional practice and guiding internal accountabilities. Is there any evidence that these changes, which other research has linked to major improvements in student learning,[36] are occurring along these dimensions as well?)

**The Basic DED Infrastructure**

If one looks broadly across applied research and development in education (including activity in the commercial sector), our field has actually acquired considerable experience in such matters as product design, intensive qualitative field studies and larger scale implementation and efficacy trials. How these tools are effectively interwoven, however into coherent programs of sustained D-E-D from prototyping, to multiple stages of redesign, up to large-scale take-up however is less well understood. We see three overlapping phases here, each with its own purpose and appropriate methods.

*Phase 1: α Level Innovation Development*

The design objective here is to develop a working prototype of some new tool or social practice. This phase of activity typically makes heavy demands on school practitioners who carry considerable responsibilities. Because the nature of the activity involves rapid prototyping (trying something out, modifying it based on field experience, followed by more field testing etc.), it places a premium on developing and maintaining a strong number of α co-development sites where it is simply taken for granted that "this is part of what we do here". These sites need to be typical in terms of student populations,

reform problems being confronted, and general resources available to address them. On the other hand, these sites must be carefully selected and supported to be high in the human and social resources necessary to sustain α level co-development. Depending on the nature of the D-E-D, this activity may also make demands on the technology infrastructure, require broad work rule waivers with regard to use of time, and ability to experiment with other core resource allocation processes (for example, class sizes and composition). As noted earlier, such D-E-D will likely require authority relationships akin to charter school agreements. While such D-E-D site conditions are necessary to support innovation development, these α sites also represent a critical first test. Basically, if one cannot make the innovation work under these conditions, it is unlikely to work anywhere. Depending on the particular innovation, α sites could be classrooms, schools, networks of schools or whole communities.

The primary research objective during this phase of activity involves informing rapid prototyping and developing the first small-scale evidence of effects at the work activity level. The research tools used in this phase will rely heavily on participatory observations, interviews and focus group discussions, possibly supplemented with some more structured analyses (for example, examination of possible data use created by the technology itself).

*Phase 2: β Level Field Trials and Making Innovations Robust*

At this point, the design task expands to consider how diversity among individual participants and contexts shapes the take-up of an innovation and how the innovation itself may need to be modified to "enhance fit". This process of making the innovation "field ready" is complemented with design activity focusing on developing structured

learning processes and expanding the base of expertise that will be available to assist others in using these new tools and social practices.

During this phase of activity, D-E-D needs access to a standing network of schools to support these innovation robustness trials, to develop some multi-site evidence on efficacy, and to expand the human resource base that has some working expertise with these new tools and social practice. (The latter is a key development objective in preparation for working at scale in phase 3.) To facilitate this activity, pre-existing arrangements need to be established with districts, CMOs and other networks of schools so that such β level field trials can efficiently proceed. One might imagine state or federal funding that provides incentives to districts or CMOs to partner in this process. The participating schools might receive supplemental funding to cover the additional time required of teachers, the additional staffing needed to both educate children and support the D-E-D programs and to remunerate the special expertise that participants bring to this work.

From a research perspective, efforts focus on understanding the sources of variability in innovation implementation and effectiveness, not just assessing the average treatment effect. These efforts, for example, seek to clarify the normative and structural pre-requisites for a successful take-up, including specific SOPs that may need to be challenged and learning how to catalyze the necessary "creative conflict" for productive change to occur. D-E-D during this phase typically involves larger-scale field trials using structured inquiry protocols. This latter instrumentation is itself an important design task, as increasing attention shifts toward building the necessary instrumentation for managing work at scale (that is, the tool kit for γ level efforts.)

*Phase 3: Large-Scale Field Adoption*

The γ level activity involves more than just marketing an effective practice. D-E-D focuses on generative learning about the innovation through large-scale use. Efforts are made to amass and mine emerging new data bases, to develop practice improvement networks around new data and tools and to reflect on what has been learned that might help to inform the next round of activity. In addition, the spillover effects from the early engagement of commercial partners into the D-E-D are likely to manifest at this stage. Through their participation in α and β activity, processes of individual and organizational learning are being stimulated within these firms. As a result, when partnering firms move to bring efficacious innovations to scale, they are more likely to design appropriate strategies and organizational capabilities, based on their evolving learning, rather than attempting to put the innovation into the "box they have always know." [37]

**Finally, Who Might Support All of This: Catalyst, Shepard and Sugar Daddy?**

Lastly, there is the large question as to who might actually catalyze developments of the type described above. Given the problems discussed in the introduction, it seems unlikely that a new D-E-D infrastructure will arise spontaneously out of the academy, public schools or the commercial sector. Similarly it is not likely that individual states will take this on, as a "free rider problem" is embedded here. While it is logical to conceive of this as federal responsibility, especially in terms of the funding D-E-D efforts at scale, the federal history in education research is not especially promising. Political ideology has deeply intruded into agenda-setting processes. Moreover, institutional expertise and governmental capacity to lead a novel and ambitious effort of this sort is thin. In addition, such an admittedly entrepreneurial enterprise places a high premium on

institutional trust, as many D-E-D initiatives will likely fail in the course of developing a few true successes. For these and other reasons, it remains uncertain whether this institution-building could succeed in the current Washington climate.

In contrast, the launch role seems like a potentially high leverage investment for private philanthropy. With greater flexibility to operate and an environment where failure entails lower risk, the odds for a successful launch of a D-E-D enterprise should be much better. Moreover, if this does in fact succeed, one could easily envision the federal government becoming a more central partner over time. In fact, accessing federal resources would be critical once a viable organizational design and expertise base has been established. Whether the initial institution building task can be directed centrally on the other hand, is far less clear.

[1] The institutional and organizational structure for our current public education system came into existence early in the 20th century and quickly became the dominant paradigm for educating America's youth. The history of the emergence of this system is detailed in David Tyack's classic book. David Tyack, *The One Best System* (Cambridge, MA: Harvard University Press, 1997).

[2] Hugh Burkhardt & Alan H. Schoenfeld, "Improving Educational Research: Toward a More Useful, More Influential, and Better-Funded Enterprise," *Educational Researche*r 32, no. 9 (December 2003) 3-14.

[3] Whittle estimates an even smaller amount, 260 million per year, spent currently in the U. S. on educational R&D. Chris Whittle, *Crash Course: Imagining a Better Future for Public Education* (New York, NY: Riverhead Books, 2005).

[4] This paper focuses on problem solving R&D in education. Key institutions supporting this activity are professional schools of education. While our remarks here can be interpreted as an implied criticism of these institutions, the concerns raised here can, and have, been raised more generally about professional schools, O'Toole's (2005) for example offers a similar critique of graduate schools of business. Warren G. Bennis & James O'Toole, "How Business Schools Lost Their Way," *Harvard Business Review*, May 1, 2005.

[5] For a further discussion on this point, see Hiebert, Gallimore, and Stigler who detail an attractive vision for developing a professional knowledge base out of and in conjunction with clinical practice. That these ideas are viewed as innovative, which they are, is quite telling about the state of this overall enterprise. James Hiebert, Ronald Gallimore & James W. Stigler, "A Knowledge Base for the Teaching Profession: What Would it Look Like and How Can We Get One?," *Educational Researcher* 31, no. 5 (June/July 2002) 3-15.

[6] Tom Corcoran, Susan H. Fuhrman, & Carol L. Belcher, "The District Role in Instructional Improvement," *Phi Delta Kappan* 83, no. 1 (September 2001) 78-84. .Noteworthy, this phenomenon is not limited to education. For a similar account in the business context, see Jeffrey Pfeffer & Robert I. Sutton, *Hard Facts, Dangerous Half-Truths and Total Nonsense: Profiting from Evidence-Based Management* (Cambridge, MA: Harvard Business School Press, 2006).

[7] See Cohen, Moffitt and Goldin for an excellent essay that explores the dilemmas embedded in effective policy actions for practice improvement. They argue that the more ambitious the policy intent, the less likely that a ready capability exists to advance these ends. In this context, districts make choices in an effort to manage these new demands that often have the consequence of subverting the ambitious intents of the policy. In the end, neither the necessary innovation development nor capacity building to advance use occurs. David K. Cohen, Susan L. Moffit & Simona Goldin, "Policy and Practice: The Dilemma," *American Journal of Education* 113, no. 4.

[8] See research studies by Melissa Roderick and colleagues on the Consortium web site, www.consortium-chicago.org.

[9] These remarkable developments have been extensively documented by the High Performing Learning Communities Project at the Learning Research and Development Center (LRDC) at the University of Pittsburgh. Many of the lessons learned here proved formative for subsequent LRDC work in initiating its Institute for Learning.

[10] Louis Gomez & Guilbert C. Hentschke, K-12 Education: the Role of For-Profit Providers (forthcoming). In Bransford, J. Gomez, L., Lam, & N. Vye (Eds.) *Research and Practice in Education: Toward a Reconciliation. Harvard University* Press.

[11] As a personal note, for several years one of the authors (Bryk) I served on the investment partners' board of the New Schools Venture Fund, where from time to time we would review proposals for support from social entrepreneurs seeking to develop new tools and services for the educational marketplace. Products aimed at the home marketplace were regularly viewed as better financial bets than those aimed at schools.

[12] Chris Whittle, *Crash Course: Imagining a Better Future for Public Education* (New York, NY: Riverhead Books, 2005).

[13] We have deliberately chosen this title of design-engineering-development efforts to distinguish it from more conventional educational research that has historically been conducted under the umbrella of "research and development". Following arguments developed by Burkhardt and Schoenfeld ,the emphasis

in this applied research is on the acts of design, engineering (for example, rapid prototyping, field testing, revision, retesting etc.) and development of capacity for use at scale. While such work is ripe for also teasing out more basic conceptual understandings about practice (for example, general knowledge development), in a DED environment this is now viewed as a valuable by-product of this practical activity. In this regard, DED stands in sharp contrast to design experiments where the primary intent is usually new knowledge development. Hugh Burkhardt & Alan H. Schoenfeld, "Improving Educational Research: Toward a More Useful, More Influential, and Better-Funded Enterprise," *Educational Researche*r 32, no. 9 (December 2003) 3-14.

[14] In extolling the potential virtues of new forms of partnership, we are also cognizant that many potentially serious pitfalls may also lie ahead. The design of the enterprise itself demands critical inquiry and may be best thought of as an evolutionary design problem where more formal institutional structures take final form through the actual conduct of the work.

[15] We wish specifically to acknowledge the contributions of Diana Joseph, Nichole Pinkard, Lisa Walker, and Lisa Rosen with whom we have collaborated on developing the overall framework for the IIS group. For a further discussion of current work activities of the IIS, see Bryk and Gomez .Anthony S. Bryk & Louis Gomez, *The Research and Practice of Shaping Schools Toward Evidence-Based Cultures* (A symposium presented at the AERA annual meeting; papers available at www.iisrd.org).

More generally, we wish to acknowledge the support of the Center for Urban School Improvement at the University of Chicago, which is the organizational hub for IIS and its affiliated charter school, North Kenwood Oakland, whose principal (Stacey Beardsley) and staff have collaborated in numerous alpha developments activities of the IIS. Similarly, we wish to acknowledge the extraordinary contributions to this work by the Literacy Collaborative at Ohio State University (Gay Pinnell and Pat Scharer) and Lesley University (Irene Fountas.) In addition to bringing their literacy teaching and learning expertise to the group, they have been co-investigators in our larger beta level field trials. Finally, a special thanks to our commercial partners, Teachscape and Wireless Generation. Their respective leaders, Mark Atkinson and Larry Berger, have been very supportive of our R&D, have brought the substantial technical expertise of their companies to bear on this work and gently but continuingly remind us about what it takes to build and bring successful new products into the marketplace. Funds from University of Chicago endowment helped to establish a technology group within USI, out of which came the IIS. Core funding for the work of the IIS comes from multi-year general operating support from the MacArthur Foundation and the Hewlett Foundation. This is supplemented by additional federal grants for specific projects. Combined, the group currently operates on about 1.5 million a year budget.

[16] To be clear, we are referring here simply to the incorporation of these new tools for administration and collection of student data in regular classrooms practice. In contrast, the ongoing analyses of these data and drawing out the implications for changing instruction can be much more complex. The degree of the latter however depends on the nature of the instructional system in which these data are embedded. For example, in a basal-driven reading curriculum, data integration may simply consists of , "if the score fall below some cut point, go back and re-teach pages yy to zz". In contrast, in a comprehensive literacy curriculum, which seeks to integrate skill development activities in the context of broader literacy activities, the prescription phase for differentiating instruction can be much more complex. As the complexity of the task increases, new demands are placed on teacher learning, the likelihood of teachers experiencing failure in these new tasks increases, and maladaptions that divert efforts away from the original ambitious reform objectives are likely. Again, see David K. Cohen, Susan L. Moffit & Simona Goldin, "Policy and Practice: The Dilemma," *American Journal of Education* 113, no. 4

[17] It is important to note that even at the simple end of the innovation continuum, practices like these are often undertaken in a superficial manner. In the case of 10 week formative assessments, for example, use of this data might mean simple going back and repeating previous lessons even though they did not work the first time.

[18] The roots for this argument can be found in Thomas Friedman's widely read book, *The World is Flat*. Thomas Friedman, *The World is Flat* (New York, NY: Farrar, Straus, and Giroux, 2005). The educational implications for this are teased out in further detail by two labor economists, Frank Levy and Richard Murnane. Frank Levy & Richard J. Murnane, *The New Division of Labor* (New York, NY: Russell Sage Foundation, 2004). See also Daniel H. Pink, *A Whole New Mind* (New York, NY: Riverhead, 2005).

[19] We note that District 2 no longer exists within the New York City public schools. It disappeared as part of the larger district reorganization under Joel Klein. Many of the expert professionals developed in District 2, subsequently moved into leadership positions in this renew system.
[20] This is a central argument in David K. Cohen, Susan L. Moffit & Simona Goldin, "Policy and Practice: The Dilemma," *American Journal of Education* 113, no. 4.
[21] The Success for All Foundation and the National Writing Projects are two other good examples of intermediate organizations, which are quite different from each other, but have both been successful in sustained D-E-D work around school improvement.
[22] This is closely related to the idea of professional development schools which has had salience in education for the past two decades. The idea discussed here, however, entails a considerably more radical change than we have seen to date in most professional development schools. Basically, professional development schools accept as given most of the organizational constraints of public schools and schools of education and seek greater collaboration among these two parties given these constraints. While significant improvements have surely occurred, they still fall far short of the teaching hospital image that originally inspired this movement.
[23] Much of the initial expertise base for District 2 drew on consultants and staff developers from Australia and New Zealand where many aspects of what we now term "comprehensive literacy was first developed. Numerous District 2 staff were trained in Reading Recovery which also began in New Zealand. Similarly some of the clinical tools for guiding teacher practice, such as the Running Record, had previously been developed and refined there. Our key point here is that District 2 was not an immaculate conception but rather drew on extensive pre-existing human, intellectual and social resource base to catalyze its own subsequent developments.
[24] This same theme was echoed in panel commentary offered by Larry Rosenstock during the AEI conference.
[25] For related work on this topic see Coburn's analysis of changes in classroom practice in California that occurred as a consequence of a decade of policy efforts to enhance literacy instruction. Cynthia E. Coburn, "Beyond Decoupling: Rethinking the Relationship Between the Institutional Environment and the Classroom," *Sociology of Education* 77, no. 3 (July 2004) 211- 244.
[26] The DLLT tool is designed both to provide scientific evidence about teacher development and to be used clinically by literacy coaches and teachers in charting out professional development plans. For a further discussion of the DLLT see Kerbow, Bryk, Pinnell, Rodgers, Hung, Fountas, Scharer and Dexter (under review). David Kerbow, Anthony S. Bryk, Gay Su Pinnell, Emily Rodgers, Carrie Hung, Patricia L. Scharer, Irene Fountas, Emily Dexter, *Measuring Change in the Practice of Literacy Teachers* (under review, currently available online as a technical report at www.iisrd.org).
[27] One interesting example in this regard was the technology development efforts in the Chicago Public Schools lead by David Vitale. Even though technology has changed virtually every workplace, it has failed in many districts to gain a stable toe-hold in the general revenue budget. Vitale's strategy instead was to fund this as a capital improvement. Some parts of the activity, such as wiring buildings and network infrastructure, were truly capital items, but they also folded in here staff training, human resource infrastructure to support use, and leasing arrangements to replace technology on a regular basis. In other districts the latter might have to compete with textbook purchases and other instructional supplies. Through this fiscal strategy, Vitale assured that an important district development would be buffered from other competing demands, even as the district went through several years of general budget retrenchment.
[28] The ideas discussed in this section draw heavily on an ongoing collaboration in the Information Infrastructure Systems group. This is, in turn, drawn from a larger working manuscript in progress in collaboration with Nichole Pinkard, Lisa Rosen and Lisa Walker.
[29] To the extent evidence is brought to bear here at all, the natural tendency would be to look at student learning gains (value-added indicators) to evaluate program effectiveness. While this does provide overall summative evidence, it says little about where in the micro causal cascade improvements might be engineered. An intentional design was put in place for professional development. Do teachers participate? If so, do we have evidence about what they learned? If they learned what we intended to teach them, is this new knowledge and skill manifest in the classroom? Finally, is there any evidence than when such practices are manifest, increases in student learning occur? A generally well-designed program could still have a flaw at one or more of these steps, but absent systematic evidence about this, improvement activities resembles a random walk.

[30] For a further elaboration along these lines see Ted Kolderie, *Education Evolving: Innovating with School and Schooling* (personal manuscript, 2007).
[31] This is a capsule summary from a separate working paper in progress.
[32] While we posit that the core elements in the framework summarized here are essential for innovation development, this set of propositions are and should be subject to empirical study. Inevitably, they will be modified, perhaps substantially, through both formal study and practical experience. Thus, a significant aspect of the overall D-E-D enterprise involves "extending this conversation" and thereby further detailing these key elements, and how they interrelate with one another, to form a useful theory of practice improvement in education .
[33] For an excellent conceptual and empirical account on these points in the context of technology use in schools see Yong Zhao & Kenneth A. Frank, "Factors Affecting Tech Use in Schools," *American Educational Research Journal* 40, no. 4 (Winter 2003).
[34] For a detailed account of school context effects on efforts to improve reading instruction, see Cynthia E. Coburn, "Beyond Decoupling: Rethinking the Relationship Between the Institutional Environment and the Classroom," *Sociology of Education* 77, no. 3 (July 2004) 211- 244.
[35] To complete the framework, we should also add that each school exists within an external institutional environment, fashioned by district, state and federal policies that provide resources and constraints, and that offers incentives and sanctions, which aim to delimit and control appropriate individual behavior. While reform efforts now seek to make this environment more coherent and 'aligned", this external environment still tends to exert a largely entropic effect as schools remain highly open to its multiple, often competing influences. Developing the latter point, however, is not essential to advancing the basic arguments offered in this paper.
[36] For an integrated summary of foundational work along these lines see .Fred M. Newmann & Associates, *Authentic Achievement: Restructuring Schools for Intellectual Quality* (San Francisco, CA: Jossey-Bass, 1996). For a recent large scale, longitudinal analysis of school organizational change and its effects on enhancing student learning see Anthony S. Bryk, Penny Bender Sebring, Elaine Allensworth, , Stuart Luppescu John Q. Easton, , *Organizing Schools for Improvement* (Chicago: University of Chicago Press, in press).
[37] We wish to acknowledge Larry Berger for this insight.