Generating Improvement Through Research and Development in Education Systems

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REVIEW

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M. Suzanne Donovan

To effectively address problems in education, research must be shaped around a problem of practice. Reorienting research and development in this way must overcome three obstacles. First, the incentive system for university researchers must be changed to reward research on problems of practice. Second, the contexts must be created that will allow the complexity of problems of practice to be understood and addressed by interdisciplinary teams of researchers, practitioners, and education designers. And third, meaningful experimentation must become acceptable in school systems in order to develop a better understanding of how to effectively stimulate and support the desired changes.

The connection between research and practice in the field of education has been weak (*1*). The "knowing-doing gap" is lamented in other fields as well, including business management (*2*) and medicine (*3*). But it is difficult to find a parallel in education to the design of digital devices by technology companies that have fundamentally changed how we go about our daily lives, or the application of biomedical research to save lives in extreme circumstances.

How might we make use of research knowledge to pursue new possibilities and design new tools and processes to improve education? The fact that other sectors have made major strides in some regards, yet struggle to reliably incorporate verified improvements into practice, highlights two distinct challenges. One is a design challenge: When research informs designs that solve a problem from the point of view of the users, barriers to change disintegrate (*4*). Doctors, for example, use magnetic resonance imaging because it allows them to see what they otherwise cannot without risky or invasive procedures. And people have changed routine behavior enthusiastically when given access to technological innovations such as smartphones and Internet search engines. But when an innovation requires that people change their behavior to achieve goals others have set—to get hospital physicians to wash their hands or to use checklists that reduce errors (*5*), or to motivate teachers to engage students in classroom discourse rather than to teach through lectures (*6*)—it is an implementation challenge (*7*). The challenges are interrelated: Greater success at designing for the user implies fewer implementation barriers. If it is made easier for doctors to disinfect their hands, they are more likely to do so. But school systems and hospitals are intended to serve the goals of others, making improvements in practice desirable whether or not the user embraces the change. Research and development (R&D) will therefore need to address both design and implementation challenges.

While the task is far from simple, its components can be described in the most basic terms. They are (i) identifying the right problem, (ii) developing effective solutions, and (iii) getting effective solutions to spread.

Identifying the Right Problem

Scientific research can be driven either by theory or by problems of practice. Research that contributes to both falls into "Pasteur's quadrant" (*8*). The National Institutes of Health and the National Science Foundation support programs of "translational research" intended to make advances in research knowledge usable for practice (*9*, *10*). The term "translational" suggests that the required knowledge is in hand. It needs only to be put into the language of practice.

Rarely do problems of education practitioners map neatly onto areas of scientific research, however. Even in the case of pasteurization, translation would be a mischaracterization. Pasteur's scientific breakthrough came with a commission to work on a practical problem: the spoiling of wine (*11*). The problem-solving research did not end with the realization that bacteria cause the spoiling, nor with the evidence that heat could be used to destroy bacteria. The heating process changes the end product—whether wine or milk—affecting taste, appearance, and digestibility (*12*). It took decades of work on the time and temperature of heating and cooling to develop the process of pasteurization that revolutionized the delivery of milk (*13*). The translation metaphor conceals the way in which research that solves problems of practice is shaped and

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disciplined by the problem to produce usable and desirable solutions.

A National Research Council Committee that explored the weak relationship between research and practice in education (*1*) concluded that, in contrast to medicine and agriculture, education researchers have few opportunities to identify the specific problems of practice that can serve as productive starting points for programs of research and development. For example, research illuminates the influence of social and emotional factors on learning (*14*). If students think effort matters, they are more likely to persevere when schoolwork becomes difficult than if they believe intelligence is fixed (*15*), and they will be exposed as having too little. And if a student believes he or she is expected to do poorly—a condition that can be manipulated in experiments—performance declines (*16*). The importance of these findings is clear, but how they might be effectively incorporated into practice is not.

One opportunity for intervention in the classroom arises when students give incorrect answers (*17*). At that moment a teacher can further explore the student's thinking, signaling both the expectation that struggling will produce learning, and that the student is capable of thinking further about the problem. However, when teachers call on another student or provide the answer themselves, their responses are consistent with a belief that "some people have it and some people don't."

Identification of opportunities like this will remain infrequent unless researchers spend time in practice settings more routinely in order to observe and articulate problems of practice for which research knowledge can contribute potential solutions. A first grand challenge, then, is to shift the incentive structures in universities and funding agencies that privilege theoretical research and its translation over problem-solving research in practice settings.

Finding Effective Solutions

Will asking the right questions guarantee effective solutions? If by "effective" we mean solutions that work in the real world, the answer is no. Efficacy trials attempt to control interactions with the system and those in it in order to create fidelity. But this is not a test of a system's ability to achieve those outcomes under normal conditions (*18*). The many ways in which a system acts to reject or undermine an intervention must itself be treated as a set of problems to be solved (*19*). The treatment of adolescents hospitalized for cystic fibrosis provides an example, and bears all the marks of an education problem, right down to the resistant adolescents (*20*). Cystic fibrosis inpatients require airway clearance therapy (ACT) four times per day, done in accordance with best practice. In a hospital in Cincinnati, best practice was used only 10% of the time, and at baseline the four sessions were done on only 41% of patient days in the hospital. Education and personal coaching of respiratory therapists, as well as salary incentives to following best practice, failed.

Identifying the obstacles to full implementation resulted in a list of 30. Patient behaviors on the list, familiar to any educator, include defiance, lack of knowledge, immortality complex, inadequate parental support, and absence of consequences. Other obstacles shared with education systems include lack of coordination among professionals, legitimate activities of lesser importance, inadequate staffing, and supply shortages.

A multidisciplinary team tackled high-leverage component problems. Psychologists used well-researched approaches for changing the behavior of adolescents, including the introduction of signed contracts, performance monitoring, and providing small rewards for follow-through. Schedules were made at intake with ACT sessions as the first priority. "Improvement research" protocols (*21*) were used to test components of practice. The incidence of best practice rose to 73%, and the number of patient days in which the recommended ACT number was achieved rose from 41% sustainably to 68% (*20*).

The initial identification of "best practice" is only a starting point for improvement. Designing a sustainable solution required varied expertise and inputs from medical practitioners, psychologists, administrators, and supply managers. And leadership was needed to galvanize the cross-functional teams toward a common purpose (*21*). A second grand challenge thus emerges: Can we create the settings in education where multidisciplinary researchers, education designers, and education practitioners are led and supported to follow the contours of problems in order to identify systemically sustainable solutions?

Getting Solutions to Spread

If a solution is designed to work effectively in a complex system under normal circumstances, can we assume that it will spread to other systems (*22*) or even be maintained in the initial site (*18*, *23*)? The answer is no. David Cutler poses the question provocatively: "Why do people and institutions not do things that are so obviously in their self-interest, even when they want to do so?" (*24*). Where one begins to look for an answer will vary by disciplinary orientation. Economists look first at incentives. The incentives lens, when focused on school systems, leads to policies that give or withhold monetary rewards for changes in system performance or practices. A focus on teachers leads to recommendations such as pay for performance or abolishing tenure. And some economists have proposed that students be paid to do well (*25*).

Sociologists look for answers in the culture and social norms of organizations. People are more likely to do what others around them do, as evidenced in smoking, eating, and exercising habits (*26*). In education settings, social norms that reject changes or prohibit questioning of a professional's practice are impediments to change (*19*, *27*). In medicine, checklists with demonstrated ability to reduce adverse incidents in surgery were used more effectively when social norms were shifted so that nurses who routinely defer to doctors were charged with calling out a checklist violation (*5*).

Psychologists look for answers in the individual's cognitive and emotional processes (*28*). External incentives and organizational norms are part of an individual's calculus, but influences also include personal goals, orientations, knowledge, and resources (*29*), as well as expectations of outcomes based on beliefs about one's ability to succeed and about reactions from others (*30*). Control over the conditions for behavior change (*31*), and the specificity of an individual's planning, also matter (*32*).

In a comprehensive study of psychological theories of behavior change, researchers in the field of "implementation science" have attempted to understand which theoretical explanation for individual behavior has the greatest predictive value with regard to medical practitioners' decisions (*33*). Several of the theories, as measured in the study, had no predictive value. Despite the breadth of the variables included, the best-performing theories explained between 25 and 42.6% of the variance in intended behavior but only 2.4 to 6.3% of actual behavior (*33*).

Confronted with so broad an array of potential contributors to behavior change, and such striking evidence of failure to scale improvements, what can be done? Invest further in the scholarly endeavor of understanding professional behavior, as implementation scientists are attempting? Deepen the knowledge base on how education organizations use research knowledge, and how they might do so more effectively? Engage in problem-solving research and development, and learn about human and organizational behavior in the process of experimenting with changing it (*24*)? All would no doubt be valuable. But if the ultimate goal is to improve practice, then problem-solving R&D has two features to recommend it. First, the lag time between the initial investment in research and change in practice will be shorter if the new knowledge is generated as a by-product of testing interventions in practice. This is particularly important if practitioners are to see value in research. Second, there is evidence that the contributors to behavior privileged by economists, sociologists, and psychologists are all important in some contexts. When either the importance of context or its variation is low, theoretical research may be an efficient route to generating knowledge that is relevant to practice. This would be the case if the goal were to understand how students grasp the concept of quantity, for example. But when both the importance and the variety of contexts are high, as with shifts in professional practice, generating knowledge by intervening and observing what happens is likely to be more

illuminating. If, for example, teachers shift more willingly to inquiry teaching when they have routine opportunities to problem-solve with their colleagues, when the materials are replenished by a designated staff member, and when parents are given weekly updates about science activities, it is difficult to imagine that such contextual factors could be identified without experimenting in practice settings. Moving from practice to theory is likely to be more fruitful than the reverse. But it will require that meaningful experimentation in education settings become acceptable. This is the third of the grand challenges.

Supporting Experimentation in Education Settings

The concept of experimentation does not sit well in systems that are highly accountable to the public. Parents would need to be persuaded that their children's education was not being jeopardized. And school system administrators and teachers who have many constituencies, none of which clamor for experimentation, would need to have the time, resources, flexibility, and incentives to engage in experimentation.

While each of the grand challenges is daunting on its own, they become oddly less so as a set. If, for example, there were practice sites where R&D collaborations were supported routinely (challenge 2), then researchers may find time spent working in those settings to be more productive and more supportive of goals related to quality and number of publications (challenge 1). And consistent financial support for such sites would provide an incentive to overcome an aversion among educators to experimentation, allow for the development of a different culture that is consistent with the designation as an R&D site, and provide the potential for a shift in the perception of parents regarding experimentation (challenge 3)—just as hospitals associated with experimental research and development are often sought out because they are on the leading edge.

There are signs of movement. Increasingly, researchers are partnering with school districts to tackle problems of practice (*34*), and funding agencies are beginning to award grants for research partnerships (*35*). Two efforts are under way to establish organizational structures to support research in practice settings. The Strategic Education Research Partnership (SERP), incubated at the National Research Council, is creating R&D "field sites" with school districts in which multidisciplinary teams of researchers and education designers are recruited to work on problems of practice identified by the districts (*36*). The Carnegie Foundation has created a model for "Networked Improvement Communities (NICs)" involving an organizing "hub" and partner organization "spokes" (*37*). NICs address multiple drivers of change related to a core problem of practice. Both models show promise for addressing design and implementation challenges. Federal funding agencies are creating new grant competitions that emphasize research-practice partnerships. But in relation to the size of the education sector, these efforts are miniscule.

The rapid pace of technological change has created new possibilities for education, at a time of emerging consensus on the critical importance of improving our education system. To seize the moment, we will need to think and work differently. There will be no "silver bullets" that will transform education systems from the outside—not in the form of new standards, assessments, programs, or technologies. While these changes are important, they will come up against inevitable implementation barriers. But if we create the organizational capacity for researchers and design experts to work with practitioners inside the system, we could potentially change the outcome. It will be possible to identify opportunities to use technology to solve problems that students, teachers, and administrators are trying to solve and to follow the contours of the implementation problems that arise as new standards, practices, and assessments are introduced. New knowledge and new technologies will have their best chance at improving school systems if the nation invests in that capacity.

Grand Challenges

Shift incentives to encourage education research on the real problems of practice as they exist in school settings. The current incentive structures in universities and in agencies that fund education support theoretical research and its "translation" for practice. Those incentives must shift to encourage research on the problems of practice in practice settings.

Create a set of school districts where long-standing, multidisciplinary teams work together to identify effective improvements. Because the problems of practice are multidimensional, addressing them effectively will require the creation of settings in which teams of researchers, practitioners, and education designers are supported to follow the contours of a problem in order to identify effective improvements.

Create a culture within school systems that allows for meaningful experimentation. Because contextual factors are critical to the effective scaling of improvements, experimentation in real school contexts is critical. This will require a major shift from the belief that experimentation is inappropriate in schools systems to the belief that it provides new opportunities for the success of education professionals and the students they serve.

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