The 21st century will require knowledge and skill well beyond the basic levels of reading and arithmetic that American schools know how to produce more or less reliably. Delivering a “thinking curriculum” to all American students requires major reform in the ways schools and districts organize their work. The transformation of the institution of schooling that will be needed to make this aspirational goal a real achievement is daunting. This article examines cognitive science, systems engineering, and social science concepts that are pointing toward a new foundation for policies and practices that may radically improve the proportion of students who can achieve true 21st-century skills.

Keywords: education organization; high-demand curriculum; human capital; instructional leadership; learning systems; professional development; routines; social capital; systems engineering; 21st-century skills

A decade into the 21st century, we still find ourselves nearly as unprepared for what our students and society need from education as we were when A Nation at Risk (National Commission on Excellence in Education, 1983) was first published. We are calling for “career and college readiness” for all American high school students and for a focus on learning “21st-century skills,” yet we find these terms hard to define, much less translate into meaningful action. The overused phrase 21st-century learning can take on real meaning only if we compare the challenges educators face now with those faced at the turn of the past century. The idea that virtually all students can, and should, learn a high-demand curriculum, focused on thinking and reasoning and grounded in mastery of complex bodies of knowledge, would have seemed quixotic to thinkers a century ago. In the last part of the 20th century, we began to imagine such possibilities and even establish them as national goals (National Education Goals Panel, 1991). But it has only been in the present century that the concept of college readiness for all has taken root as a serious education policy target.

Figure 1 provides a conceptual graph of the radically changed education aspirations that characterize our present efforts to teach 21st-century skills to virtually all American students (cf. D. P. Resnick & Resnick, 1977). The very concept of schooling for all is only a few centuries old in Western countries. It is a 17th-century invention, born during the spread of Protestant Christianity in Northern Europe and then taken up in Southern Europe as part of the Catholic Reformation. In the 19th century, basic schooling for all became a national aspiration in Europe and North America, aimed at creating “citizens” and competent participants in national defense efforts. These initial mass schooling efforts (the top left points in the graph) aimed to make high proportions of the population “literate” but set a low criterion of what counted as literacy.1 Catechism, in which individuals were asked a set series of questions culled from specific religious texts and were expected to provide standardized answers, was a basic form of instruction. Participants were judged literate if they could recite familiar texts and answer simple questions on which they had been drilled.

As schooling became more widespread, the catechism form of instruction moved into the lay classroom. The content changed to include basic arithmetic, geography, history, and some science, along with a broader range of texts for reading and writing. But schoolroom discourse remained remarkably unchanged. Students were assigned a text to read or a problem to work, and they were then quizzed by the teachers with a set of questions that basically checked on whether the students had done the assignment (Mehan, 1979; Resnick, Wiliam, Apodaca, & Rangel, in press). Across Europe and America, schooling became part of most young people’s experience. But mass schooling did not even try to engage most pupils in the kinds of knowledge-based reasoning and problem solving that characterized elite schooling from ancient times. This elite type of schooling became institutionalized in “academies” and technical institutions in the 19th and 20th centuries (see the bottom right point in the Figure 1 graph).

A sharp distinction in expectations for mass, or “basic,” education and what was taught to an elite minority still held in the
The proportion of students attending secondary school in the United States rose only very slowly over the succeeding decades. At the century’s midpoint, roughly two thirds of the school-age population was in high school. Thus the “common core” curriculum for American secondary students, became the core curriculum for American high schools (Hertzberg, 1988). The program that the committee agreed upon included the recommendation to teach English, math, and history or civics to every student in every academic year, along with recommendations for specific course sequences. With expectable debate and quarrels about which schools really counted as high schools and what “all” students should be expected to learn, the committee’s program gradually became the core curriculum for American secondary students. Yet by 1910 only about 10% of students attended school beyond the eighth grade. So the Committee of Ten curriculum is perhaps best thought of as America’s response to Europe’s elite technical schools.

Today we are aiming for something new in the world: an elite standard for everyone (star at top right of the Figure 1 graph). That is what the term 21st-century skills really means. The skills are not new (some students have been successfully learning them in some schools from the beginning of civilization). But the aspiration to successfully teach knowledge-grounded reasoning competencies to everyone is still just that—an aspiration. Is it a sensible one? Is there any reasonable prospect of meeting it? What would it take? Those are the questions I aim to answer in this essay. To anticipate, I will argue that basic human capacity for learning and thinking makes the aspiration humanly possible, if we think in terms of the learning capabilities of most individuals. But the transformation of the institution of schooling that will be needed to come close to making the aspirational goal a real achievement is huge. I will suggest some steps we might take in the near future. To do this, I will take the reader on a quick journey through a slice of national achievement data from the past two decades and a summary of a consensual cognitive science-based theory of instruction that most scholars of learning and teaching now agree on. I will then examine systems engineering and social science concepts that point toward a new foundation for policies and practices that may radically improve the proportion of students who can achieve true 21st-century skills.

Reaching for the Star: Caught in the Basics Trap

From the 1990s on, the public agenda of raising educational levels for all has been promoted under the banner of the standards movement, often accompanied by the phrase “All children can learn.” But neither term clarifies just what we have expected all children to learn and thus what the standards ought to be. The evidence is now pretty clear. We seem to have figured out how to teach “the basics” to just about everyone—with special success in mathematics. But we are deeply unsuccessful in the rest of our 21st-century agenda of moving beyond basic competencies to proficiency.

Figure 2 shows the National Assessment of Educational Progress (NAEP) fourth-grade math scores over an 18-year period spanning the end of the 20th and the beginning of the 21st centuries. The graph plots scores separately for Whites, Blacks, and Hispanics. There has been a near continuous rise in achievement scores over this period among all population groups. The achievement gap has not closed, but it has shrunk somewhat. In fact, and very much worth noting, Blacks and Hispanics were doing as well in 2007 as Whites had been in 1990. The fourth-grade math gap would have closed completely if White students had not continued to improve across the 18-year period! In eighth-grade math, the pattern is similar (Figure 3), with Blacks showing an especially steep rise, but a lower percentage of students is meeting basic eighth-grade goals.

The story is less dramatic for reading, but there is evidence that this achievement gap is shrinking somewhat as well. Over the past 20 years, guided by a growing body of scientific research, there has been substantially more teaching of the components of basic literacy (phonemic awareness, phonics, vocabulary). And this has shown up in higher first-grade scores on basic word decoding skills (National Institute for Literacy, 2008). But by fourth grade, when NAEP first measures reading, the focus is on reading comprehension—understanding what you read. There, the gains have been very small.

Overall, then, national achievement results suggest that as a nation we are en route to eliminating basic illiteracy and innumeracy. The really troubling performances of the early 1990s, in
which large numbers of our minority students, along with some White children of poverty, seemed to be fundamentally illiterate or innumerate, have changed. We are on the way to meeting our “basic education” goals—and we have achieved this even as we have absorbed growing numbers of students with limited English proficiency into the nation’s schools. It appears that the standards effort, including requirements for disaggregated test score reporting, is having the hoped-for equity effects. We are teaching basic literacy and math to more and more of our elementary school children, and fewer and fewer are being left way behind.

We are, however, very far from reaching the star. Proficiency levels on the NAEP remain low, and there are very few students of any subgroup reaching Advanced levels. Furthermore, it now seems likely that the accountability regime that appears to be creating much of the improvement in Basic skills may actually be limiting progress toward the kinds of more challenging competencies we seek. The effects of high-stakes, low-cognitive-demand tests on instructional practice have been quite widely documented by now (Koretz & Hamilton, 2006; McNeill, 2002). Most studies show that state tests have led to a noticeable increase in the amount of instructional time devoted to the tested subjects and a corresponding drop in nontested subjects (Center on Education Policy, 2008). Most districts that increased time for English language arts or mathematics also reported substantial cuts in time for other subjects, including social studies, science, art and music, and physical education (Center on Education Policy, 2008).

Even within the tested subjects, it appears that test-based accountability may be narrowing what is taught. In many urban school districts, teachers are emphasizing test preparation over other aspects of their districts’ official curricula (Shepard, 2002–2003). As end-of-year testing dates approach, teaching time is spent on test practice. In one district that we have studied intensively, elementary students stop reading and discussing grade-level-appropriate books in February and instead spend time


FIGURE 4. Definitions of knowledge, competent performance, instruction and learning, and aptitude and intelligence to which learning scientists subscribed in the 1920s and today.

digesting brief passages, accompanied by multiple-choice test items that mimic the ones that appear on the state tests. District leadership reluctantly supports this practice because the tests carry heavy consequences.

Although no one intended such an outcome, the test-based accountability movement seems to have taken the nation back to something like the minimum competency movement of the 1970s (Jaeger & Tittle, 1980), which was an effort to ensure that poor and minority students would at least be taught the basics—but with no grounded approach to high-cognitive-demand learning for the great majority of students.

Reaching for the Star: The Thinking Curriculum

Despite the rhetoric of 21st-century skills, we have by and large built our accountability system so that it actually suppresses the kind of learning that the 21st century calls for. Since the middle of the 20th century, the science of learning, and thus the underpinnings for trying to reach the gold star of knowledge-based reasoning for all Americans, has expanded substantially. The recommendations now coming from an expanded, multidisciplinary learning science community are substantially different from those of the first half of the 20th century (Resnick, 1987b, 1999). The transformation of learning theory over a century of its attempt application to schooling is remarkable. Scientific research on learning has produced changed concepts of knowledge itself, new criteria for what counts as competent performance and as intelligence, new principles for instruction, and even new theories of how educational organizations work.

Figure 4 compares definitions of knowledge to which learning scientists subscribed in the 1920s and today. Instead of defining knowledge in terms of a bounded list of facts (“bonds” as E. L. Thorndike, 1932, called them) coming from a small number of controlled sources, we now define knowledge in terms of schemas and conceptual structures. We recognize that knowledge comes from multiple sources and that it is often public, rather than controlled by academicians. And we know now that knowledge is exploding every day, that it is emergent from the complex interactions in which people engage.

Our changed understanding of knowledge leads to changed views of what counts as competent performance. Automated skill in performance of routines still matters, but 21st-century skills mostly focus on a person’s ability to participate in argumentation and discussion. Question-and-answer performances are replaced by discursive processes that include productively challenging colleagues, paraphrasing, and interpreting presentations by others. And although individual performances still matter, much “knowledge work” is “distributed,” involving collaboration with others (Resnick, 1987a).

These new concepts of knowledge and competence entail new understandings of how instruction and learning can best proceed. Although practice and repetition still play a role in acquiring a relatively narrow set of skills and information (e.g., solving algebra problems speedily and accurately), we now recognize that reliable learning of complex material will proceed through a process of interpretation and explanation. Instead of just “stamping in” correct answers and “stamping out” the incorrect (as Thorndike taught us in the 1920s), we now try to teach students the metacognitive capabilities of self-monitoring and self-management of learning. And we recognize that there are important social aspects of learning, even when each individual is responsible for mastering some body of skill or knowledge.

There have also been important changes in how we think about aptitude and intelligence. Instead of intelligence being viewed as an “entity,” something that people have a fixed amount of and that—for many—limits learning possibilities, we now understand intelligence to be learnable (Dweck & Molden, 2005; Resnick & Nelson-LeGall, 1997) through social processes that include participation in certain forms of high-demand learning.

These changes in our understanding of learning point toward a form of instruction that I have come to call the Thinking Curriculum (Resnick, 1987b; Resnick & Klopfner, 1989). The Thinking Curriculum calls for instruction that is high in cognitive demand (conceptual learning, reasoning, explaining, and problem solving are engaged daily) and that is embedded in specific, challenging subject matter. Evidence has accumulated that teaching cognitive skills in the absence of specific content rarely works. It appears that thinking abilities have to develop in the course of reasoning about specific information and knowledge. At the same time, there is plenty of evidence that drilling on the facts without demands for explanation and reasoning produces fragile knowledge, which is likely to disappear once the test is over and is unlikely to transfer (Chi, 2000). A form of the Thinking Curriculum that uses guided classroom discussion of core disciplinary ideas (we call this accountable talk) apparently yields both long-term retention and transfer to other disciplines (Resnick, Michaels, & O’Connor, in press). The strongest examples come from controlled experiments in which an individual teaches elementary mathematics in the Thinking Curriculum style and in the traditional recitation style (e.g., Bill, Leer, Reams, & Resnick, 1992; O’Connor, 2001).
Other studies, in which multiple teachers are trained to teach science or math discursively, produce less dramatic differences in scores but still show significant transfer effects on measures of general cognitive functioning across disciplines (e.g., Adey & Shayer, 2001; Mercer, Dawes, Wegerif, & Sams, 2004).

Scaling the Thinking Curriculum: An Organizational Design Problem

We know that the Thinking Curriculum can actually work for a broad range of individual students. The question now is whether we can figure out how to “scale” the kinds of teaching that are needed to reach the 21st-century star. Doing so will mean preparing educators to adopt a significantly different way of teaching than most of them experienced in the course of their own schooling. Doing so will call not just for pedagogical shifts but also for deeper knowledge of core subject matter than many current teachers have—perhaps especially in mathematics and science.

Consider mathematics, which is the field that has made the greatest advances in codifying methods of teaching that ensure both mastery of basic skills and conceptual understanding and problem solving. To successfully lead a Thinking Curriculum mathematics class, a teacher must be able to recognize the mathematical content embedded in initially ill-formed articulations of concepts and explanations. Then, the skillful teacher orchestrates classroom interactions—including challenges, revoicings, and targeted discussions of student explanations—that bring the important concepts to light in a form that all students can share (Michaels, O’Connor, & Resnick, 2007).

Compared to traditional mathematics teaching (see Stigler & Hiebert, 1999) in which the teacher leads the class through a relatively simple script of choosing and naming the correct steps in a procedural task, Thinking Curriculum instruction calls for guiding an only partially scripted line of talk, one in which children’s initial formulations of ideas are halting and filled with non-technical language.

This kind of teaching is not “discovery learning” in which children are free to explore a problem space, with the teacher riding along for the adventure. Instead every class session has a clear intellectual goal, a kind of “macroscript” for a directed conversation—has a clear intellectual goal, with students working out specific conceptual understandings under teacher guidance. The class traverses the script in a series of “byways,” some introduced by students who are struggling to articulate their understanding of a concept, others introduced by students already confident in their knowledge. Both kinds of students are likely to be present in most classrooms.

Thinking Curriculum lessons are also not simply “collaborative learning” (Johnson & Johnson, 1986; Slavin, 1996), with which they share important features (most obviously the importance of student talk and explanation and the possibility of groups of students working on their own for portions of the instructional time). In effective Thinking Curriculum classrooms the teacher does not simply “step back” and let students discover knowledge or problem solutions for themselves. Instead, the teacher guides a knowledge-driven discussion focused on explaining concepts in the context of specific texts, tasks, and interpretive questions. Every class session—or small-group meeting—has a clear intellectual goal, with students working out specific conceptual understandings under teacher guidance. The teacher is guided by a macroscript that specifies the goal (student understanding of specific concepts) and some likely landmarks along the way, with the route to the goal marked by explanatory byways. These byways are crucial for building understanding, but it is also crucial to return to the planned path (Ball & Lampert, 1998; Lampert, 2001; Lampert & Ball, 1998).

All this requires confident subject-matter knowledge on the part of teachers. What works in the Thinking Curriculum is not generic but deeply subject-specific teaching. Yet considerable research has documented the weak mastery of core subject matter by many teachers educated in our current system (Cloftefter, Ladd, & Vigdor, 2007; D. K. Cohen & Hill, 2000). So there is a substantial challenge ahead for teacher preparation programs and teacher credentialing in terms of creating incentives for high performance and on-the-job training. All these proposed solutions focus on populating schools with better educated teachers (i.e., improving the human capital of the education sector—see below for further discussion). That is important. But by itself it will not create enough good teaching to go around—that is, to reach all of our students. The challenge to individual teachers is matched—perhaps exceeded—by the challenge to educational organizations and the policy structures within which they act.

Current policy discussions often aim to solve the problem of disappointing levels of learning by investing heavily in theories of performance management. The prescription for better performing schools, according to this theory, is more frequent measures of student performance and greater attention to this “output” data (in economists’ terms, “productivity”). This has led to a virtual industry of student measures that can be administered early and often, in the form of interim, or benchmark, tests. As noted earlier, these tests have come to control the de facto curriculum, as school districts and school principals—worried about poor performance on state accountability instruments—prescribe more and more test preparation, mostly in the form of practicing items that are very like the ones that will appear on the state tests. These items, for reasons of cost, familiarity, and certain psychometric considerations, are mostly simple multiple-choice questions, with little opportunity for the kind of interpretive knowledge work that the Thinking Curriculum calls for. This growing practice, encouraged by the offerings of test providers, inflates attention to the end-of-year test items and exaggerates the “basic skills” character of the standards movement.

Even if the accountability tests were to be changed substantially (along lines being discussed today in many venues), performance management based on student test scores alone would be a far cry from what is needed to build a new educational and organizational management system that can support, enhance, and sustain the Thinking Curriculum. We need a method closer to systems engineering (Resnick, Besterfield-Sacre, Mehalik, Sherer, & Halverson, 2007), one that examines processes along a chain of linked policies and actions.

Process management was widely embraced in the 1980s in the business world under labels such as total quality management (TQM) and ISO 9000. A catalyst in this movement was then Secretary of Commerce Malcolm Baldridge, for whom the Malcolm Baldridge National Quality Award was established by an act of Congress in 1987. TQM is not specific to any one type of organization and was considered applicable to education and government agencies as well as the private sector. During the
1990s there were attempts—largely encouraged and funded by the American business community—to apply TQM to education (e.g., a Malcolm Baldridge award for school systems was initiated). Key to the TQM management philosophy was that all employees—from floor workers to CEOs—be engaged in seeking quality improvements and that processes as well as outputs be measured and improved as necessary. It is odd that, just as we have truly engaged the agenda of focusing on results, we seem to have left behind the attention to organizational processes that is a crucial aspect of quality management.

**Engineering a Nested Learning System for the Thinking Curriculum**

The systems engineering concept of process control (Turner, Mize, Case, & Nazemetz, 1992) provides a foundation for organizational design that goes beyond just measuring outputs. Originally introduced for manufacturing organizations, systems engineering approaches have also been heavily applied to the service industry, including financial, medical, and educational organizations. A notable example of how process engineering has focused on the values and needs of people is the redesign of hospital systems—including improved surgery room functionality, reduction of errors in medical procedures and medicine distribution, improved diagnosis systems, improved scheduling to reduce patient waiting times, and effective distribution of information and resources to minimize hospital costs (Sahney, 1993).

Figure 5 provides a schematic of how a process control system would work in a manufacturing setting. The production process (circle in the bottom line of the figure) is where the fundamental work on the “product” is done, using a variety of input resources—materials, people, and so forth (shown to the left of the production process circle). The quality of the end product and the processes used to produce it are both continuously measured. Results are compared to plans (diamond at far right), and a leadership and management team (central rectangle in the figure) uses these measurement results (on outputs and processes) to decide whether the desired objectives and outputs have been satisfactorily met (Davis, 1982). When results do not meet expectations, the leadership and management team (central rectangle) takes corrective actions. Because processes as well as products are monitored, there are opportunities to determine where the process has broken down. Initiatives and plans as well as operating procedures may be modified (far left rectangle) by the leadership and management team, and resources may be reallocated to support the changes.

Figure 6 adapts the basic process control model to educational organizations—specifically large urban districts. The figure shows a “nested,” or layered, system. The production process of the preceding figure is now the classroom level. Leadership and management processes are shared between the school and the district level. Outputs (student learning) flow out of the classroom and produce data that allow results to be compared to the plan (the diamond to the right). If they are acceptable, the process is allowed to continue. If not, corrective action is determined. The pipes symbolize the ways in which influence can flow between and among levels of the system, sometimes enabling, sometimes constraining, action at the next level.

As a step toward working with urban school districts to build a process-engineering management system, the Processing Engineering for Education Results (PEER) group at the University of Pittsburgh, headed by engineer Mary Besterfield-Sacre, developed a hypothetical flow model of processes from the district to the school level. This is shown in Figure 7. The output of the system (at the right) is expected to be student learning, using multiple measures. Five types of classroom “enablers” are specified. These enablers draw on a substantial body of research—much of it beginning with John B. Carroll’s Model of School Learning initially put forward in 1963 and modified by Carroll himself (in 1989) and many other scholars (e.g., Berliner, 2006) in the intervening years. Measures for many of these classroom-level enablers exist and can be used in the process-engineering effort of school districts.
To the left in Figure 7 are hypothesized enablers (sometimes constraints) that the school or district introduces (some of the processes fall between district and school or between school and classroom). The research basis for the elements further to the left in the diagram is much thinner than for classroom processes, but there is widespread agreement in the policy making and policy research communities that each of the elements named is potentially important. In fact, many proposed policy initiatives are based on assumptions involving these elements (e.g., hire and reward teachers with more knowledge and skill, provide continuing professional development, modify principal hiring and school assignment policies).

To check our hypothesized process model against the implicit models of leaders in urban school districts, we invited key decision makers in several urban school districts to participate in a series of mapping exercises. More than 100 urban district officials (including superintendents, deputy superintendents, chief academic officers, instructional supervisors, and principals) participated. Participants were given a set of “tiles,” each containing one of the elements in Figure 7. They were permitted to discard any elements they did not deem centrally important and to add new ones, if necessary, to reflect their views. Participants were asked to create “influence maps” of their policies aimed at improving student learning. Twenty-eight groups of district officials created 28 different maps using our organizational elements and enablers plus a small number of additional ones that they added.

Although there were variations among the maps, certain characteristics were largely shared. First, our hypothesized system elements did, according to our participants, constitute the fundamentals of the K–12 system. Even though district leaders were instructed to add additional elements as needed, few were added, and there was no consistency among the additions. In addition, the pattern of influence revealed in the 28 separate practitioner maps was quite similar to what is shown in Figure 7.

We combined the qualitative knowledge embodied in our district experts’ graphs using an algorithmic approach involving a recursive path-counting routine written in VB.NET (Clark, Sherer, Besterfield-Sacre, & Resnick, 2007). The results of the VB.NET analyses identify frequently occurring paths among the 28 maps developed by our school district participants. These paths represent prominent shared theories of action among our experts for how to influence classroom processes to produce improved student learning. Four high-frequency two-element paths were identified:

Instructional leadership $\rightarrow$ teacher beliefs
Quality of professional community $\rightarrow$ teacher beliefs
Professional development $\rightarrow$ teacher knowledge and skill
School calendar $\rightarrow$ instructional schedule

Further, four individual elements (instructional leadership, quality of professional community, teacher beliefs, teacher
knowledge and skill) also appeared in frequently identified paths of three, four, or five elements. All 28 groups placed teacher beliefs in their diagrams. All but one included teacher knowledge and skill. Instructional leadership, quality of professional community, and professional development were used with high frequency. Thus, according to our participants, there is a solid core of processes essential to enabling the classroom practices that we know produce student learning.

Policy Planning: The New Reform Triangle

Although the terms human capital and social capital had deliberately not been used in our mapping exercises (to avoid having technical terms block our experts’ ability to articulate their own theories of action), the education leaders we worked with shared the underlying ideas expressed by those terms. Our participants affirmed the importance of organizational features of schools that social scientists and policy experts have been addressing for some time: human capital (expressed as “teacher knowledge and skill,” “teacher beliefs,” and “instructional leadership”) and social capital (expressed as “quality of professional community” and “effort-based instructional culture”). To these two terms, we add a third: instructional tools and routines (expressed as “appropriate assessments available,” “curriculum and materials,” “professional development”). These three organizational features comprise a new policy triangle (see Figure 8) that is beginning to guide policy designs for improved achievement—although it is rare for advocates or scholars to consider the three in combination.

Human Capital

Economists tend to be especially interested in human capital: what people in the organization know and know how to do (Harbison & Hanushek, 1992). Human capital is typically measured by credentials, performance observations, and individual outputs (in education, student learning). Economists have related

FIGURE 7. Fundamental elements of the K–12 system according to participant practitioners.

FIGURE 8. Policy triangle to guide policy design in educational settings.
Social capital refers to the ways in which people in an organization share what they know. With whom do they talk? How openly or widely do they share information—both positive and negative—about their work? Do they know or care who has expertise? How broad or narrow are their networks? Our expert educator participants referred to social capital mainly as the quality of professional community within a school and viewed it as a primary means of building human capital. Social science research supports their practice-honed view. For example, in a large study of social capital in New York City schools, high social capital (as measured by structured surveys) apparently led many competent teachers to stay in schools serving the poor, even if the teachers had opportunities for better paying jobs nearer to their own homes in the suburbs (Leana & Pil, 2009).

Instructional Tools and Routines

Human and social capital are powerful concepts, but they do not tell the whole story. As do all organizations, schools function through a set of more or less interconnecting routines—“repetitive, recognizable patterns of interdependent actions, involving multiple actors” (Feldman & Pentland, 2003, p. 113). These routines are critical for any organization to function effectively because they provide stability and continuity over time (Feldman, 2000; Feldman & Pentland, 2003; March, 1981; March & Simon, 1958, 1993) and structure action in organizations (Allison, 1971; Gersick & Hackman, 1990). Groups and individuals in the organization develop routines that constitute the normal ways in which work gets done. These routines are not always in the official manuals, but they allow members to perform satisfactorily in the judgment of clients and supervisors and for their own self-satisfaction. Such routines often involve adaptation to internal and external institutional constraints and may also recruit the power of informal “below the radar” work groups, as documented by sociocognitive research (Brown & Duguid, 2000; Orr, 1996; Resnick, Saljo, Pontecorvo, & Burge, 1997; Suchman, 1996). Research has documented the ways in which organizational routines, both formal and informal, frame and enable interactions, provide stability across time, and assist in socializing new organizational members (M. D. Cohen & Bacdayan, 1994; Feldman & Pentland, 2003; Sherer & Spillane, in press; Spillane, Mesler, Sherer, & Croegaert, 2010).

What kinds of routines might be introduced into schools and school systems that would build the human and social capital needed? There are several possibilities—ranging from instructionally based supervision systems to tools and routines for instruction. Stated most directly, it probably would help to put curriculum of known effectiveness, along with materials and procedures for classroom implementation, in the hands of teachers.
Throughout the first half of the 20th century—when school attendance was expanding, people were moving from farm to city, and American cities were absorbing then-unprecedented numbers of internal (South to North) and external immigrants—large school districts laid out well-defined curriculum and instruction plans and expected teachers to follow them. Starting in the 1960s, educational tastes changed and large pressures against “industrial” models of education developed. Over the three and a half decades since David Tyack (1974) described the functioning of centralized school systems as “Tayloristic” (referring to efficiency methods in which teachers were expected to implement detailed programs of instruction on a strict schedule), there has been a growing rejection of the idea of centrally imposed instructional programs. This has been accompanied by a rhetoric of professionalization of teachers, with the implication that professionals should develop their own instructional plans and programs.

Today, the language of professional independence for teachers is so widespread that even when school districts attempt to implement systems of managed instruction as a way of improving educational provision for underserved populations of students, they mostly cast their curriculum offerings as guidance for teachers rather than as required programs. Textbooks are adopted but often used only sporadically. In the face of high-stakes accountability for student performance on state tests, most districts offer interim assessments intended to provide guidance on how to meet student needs. In many cases, however, the actual use of such assessments is voluntary. In a recent PEER study of a large Eastern urban school district, for example, teachers reported not regularly using the district-supplied teaching materials in math (which they judged too fast paced for their students), and most did not administer the voluntary end-of-unit assessments that the district supplied.

The resistance to curriculum-based solutions is beginning to decline. There is growing evidence that structured instructional tools and routines for using them can be a powerful route to better teacher performance and increased student learning. In the next section, I report evidence that the three elements of the new policy triangle can be used together to meet 21st-century education reform goals.

**Using the Policy Triangle to Improve Educational Results**

**School-Based Instructional Tools and Routines**

Although school districts have, by and large, been shying away from—or not fully implementing—curriculum-based reform, the instruction-based reform strategy has been kept alive in American schools by some of the intervention models that emerged as part of the 1990s reform strategy known as comprehensive school reform (CSR). In the CSR approach, an individual school uses state, federal, or philanthropic dollars to contract with an organization (usually a nonprofit, sometimes a for-profit or a university group) that provides a defined service program, usually one that includes professional development and other support for teachers.

The existence of these CSR schools, using a variety of reform models, provided the opportunity for a research group at the University of Michigan (Correnti & Rowan, 2007) to compare different reform strategies’ effectiveness in raising student achievement in elementary schools. The group’s Study of Instructional Improvement research program compared schools using three different models of school improvement: Success for All (SFA), America’s Choice (AC), and the Accelerated Schools Project (ASP). The first two (SFA and AC) are curriculum-based models in which the external “provider” supplied texts and other teaching materials, specified student grouping and instructional processes in detail, and provided training in specific pedagogical strategies. ASP, by contrast, provided structured support to school staff members to develop their own instructional plans and implementations around a broadly shared philosophy of learning and teaching. ASP, in other words, focused on building social capital, whereas AC and SFA used instructional tools and routines as a route to improved student learning.

The findings were striking. Using student learning as the criterion, the curriculum-based approaches (SFA and AC) performed better than the ASP approach that worked mainly on developing social capital. What is more, the learning gains were tightly tied to the specific instruction that was the focus of the program. Each program showed significant effects only for the core curriculum component it focused on—basic reading skills in the case of SFA, writing skills in the case of AC. In other words, well-implemented curriculum worked, but the effects were specific to the tools and routines introduced by the provider.

**District-Based Instructional Tools and Routines**

Can the instructional tools and routines strategy be used to increase student learning across a broad swath of schools in a district? This is the question we addressed in an experimental study conducted in several dozen elementary schools in a large urban district in the Southwest, a district struggling to raise achievement among a large and growing population of Spanish-speaking immigrant children (Matsumura, Garnier, & Resnick, in press). The curriculum approach we introduced was based on the reading comprehension program Questioning the Author (QtA) developed by Isabel Beck and Margaret McKeown (2002). The tools and routines of QtA were introduced by placing dedicated literacy coaches into half of the schools under study and training them using a program called Content-Focused Coaching (CFC).

Coaching is a popular intervention in school districts that are trying to raise achievement. It is, in theory, a form of professional development that is school embedded and therefore close to instructional practice. It also—in theory—uses the best teachers in the system to help build skill among the larger teaching force. Using the PEER process of specifying expected influences, coaching can be seen as a means of upgrading teacher content and pedagogical knowledge, along with teacher beliefs about student ability to learn. As shown in Figure 9, coaching (the central diamond) is expected to enhance key enablers of classroom practice such as content coverage and quality of classroom interaction, thus leading to gains in student learning.

Coaching is rarely enacted according to theory, however. District practices of hiring and assigning coaches, sometimes governed by union contracts, along with job postings and salary
policies, often mean that coaches are selected from the teaching ranks by seniority or preference of principals rather than by demonstrated capacity to increase student learning. Coaches’ job descriptions are often only vaguely specified. And, reporting usually to individual principals who do not have a developed understanding of what to expect from coaches, they are assigned to a myriad of tasks (ranging from supervising testing, serving as substitute teachers, or providing personal teaching to underperforming students) and do not have the opportunity to develop a systematic coaching relationship with teachers. Figure 9 also illustrates how the quality of coaching in a school district is dependent on a large set of policies and practices (those to the left of the coaching diamond in Figure 9) that are heavily influenced by the district central office.

In our study of CFC, we enacted a carefully focused program of coaching in upper elementary classrooms teaching reading comprehension (Matsumura, Sartoris, Bickel, & Garnier, 2009). The program used to train coaches had been developed over several years at the University of Pittsburgh’s Institute for Learning (Bickel & Artz, 2001). We worked with district administrators to select demonstrably successful reading teachers to be trained as coaches. We also worked with school principals to develop agreements that would make it probable that coaches assigned to their schools would be scheduled for regular meetings with subgroups of teachers, would be allowed to make classroom visits to individual teachers, and would not have competing work assignments (Matsumura et al., 2009).

Twenty-nine of the lowest performing elementary schools, all with high proportions of English language learners, were randomly assigned to either the CFC or a comparison condition. Teachers and principals in both sets of schools responded to periodic surveys and interviews. There were systematic observations of classroom text discussions and recording of the complexity of the texts being used in instruction. Students’ reading test scores on the state accountability tests were tracked over several years.

Teachers in the CFC intervention schools significantly increased participation in coaching focused directly on classroom practice. The quality of the text discussions in their classrooms improved: The classes read more difficult texts, they actively referred to the texts as they discussed them, and the teachers used accountable talk (Resnick, Michaels, et al., in press) classroom discourse strategies. Students in the CFC schools showed significantly higher reading test scores (effect size = .25 after 2 years). The effect was strongest for English language learners (Matsumura, Garnier, & Resnick, in press; see Figure 10).

Combining Social Capital and Instructional Tools and Routines in High Schools

Many scholars of education practice and reform suggest that the quality of professional community in schools is tightly associated with student achievement. Considerable work has been done to develop ways of managing schools that are likely to build and sustain professional communities (Loeb, Darling-Hammond, & Luczak, 2005; McLaughlin & Talbert, 2001). Indeed, it is possible that the successes of curriculum-based whole-school models are in part due to the professional community commitments that are evoked by the forms of training and support that are part of the implementation packages that the sponsoring organizations build into their programs.

In 2001, the Institute for Learning began designing and piloting an intervention program that explicitly combined instructional tools and routines with professional development strategies.
aimed at building professional learning communities (McConachie & Petrosky, 2010). The institute worked in two urban districts: six high schools in Austin, Texas, in which all teachers in the four core high school disciplines (science, math, history/geography, and English) participated, and schools in the Los Angeles Unified School District in which the departments of mathematics and/or English, along with their principals, agreed to participate.

In both districts, intensive professional development led by subject matter experts was organized around a “spine” of curriculum units and lessons that were explicitly linked to the districts’ official curriculum guidance documents. The units and lessons were designed to educate teachers in high-cognitive-demand forms of classroom instruction. The form of training used was intended to induce new forms of professional engagement in what we have termed a “kerneling process” (Resnick & Spillane, 2006; Resnick, Spillane, Goldman, & Rangel, in press) in which formal routines embedded in an institution give rise to a next generation of practices that are kin to the externally introduced routine but not identical to it. Kernel routines are designed to deliberately displace standard routines of practice. Participating teachers are expected at first to follow the new routines quite faithfully. However, the routines have been developed with the goal of encouraging new forms of professional interaction that are consonant with the curriculum plan but crafted by the participants to fit their interactive and learning preferences.

The pedagogy and content routine (PCR) begins by engaging teachers in a tightly crafted routine consisting of a specific set of professional development practices. Training and practice of PCR occurs separately for each teaching discipline, but when the routine is used for several disciplines within a school (as it was in our Austin implementation), substantial “cross-seeding” and development of a larger institutional change within a school is expected to occur.

Figure 11 depicts how PCR works. Teachers, coaches, and lead teachers first experience the sequence of activities described in column 2. They begin as learners of model lessons taught by a trainer. They then engage in a trainer-led process of “deconstructing” or interpreting what their learning process has been and the role of the trainer in evoking their learning processes. Next (still in column 2), participants are asked to teach the model lesson or a modification of their own design. They are observed by the trainer and other teachers, and they then participate with the observers in an analysis of the pedagogy and content of their teaching. Teachers have the experience of both observing and being observed during this phase of implementation—always with careful attention to the content taught and the cognitive processes evoked among students. They next modify or adapt the lesson for future teaching and continue the teaching-observing-analyzing sequence. Alternatively, they can ask for one or more additional model lessons from the spine.

Even as the teacher group cycles through the PCR, the kerneling process is expected to engender new forms of school practice. As shown in column 3, we expect changes in leadership activity, in norms of trust and collaboration, and in specific collaborative

FIGURE 11. Pedagogy and content routine.
routines and structures of interaction. All of these forms of social capital should affect aspects of classroom practice (column 4) and thus of student learning (column 5).

A research team headed by Joan Talbert of Stanford University evaluated the use of PCR in the six Austin, Texas, high schools. The evaluation report (Talbert & David, 2008) suggested that PCR provides an effective vehicle for developing teacher collaboration centered on instruction, as well as for increasing the academic rigor of teaching and learning. However, the authors noted that it would need further central administration support to realize its full effects. Another study in Los Angeles (David & Greene, 2008) yielded similar results in mathematics. Implementation in English language arts, which received less intensive administrative support, was not as effective.

In Conclusion

We stand at the cusp of some potentially important shifts in how we think about education reform. Resistance to external specification of routines and curriculum seems to be ebbing. But increased policy interest in curriculum-specific instructional practices will bear fruit only if we can learn how to embed detailed curriculum guidance in organizational designs that support the complex sociocognitive practices of participants and the diversity of students in our schools. Systems that aim to develop extended knowledge and complex forms of argument and reasoning among students will fail if teachers are restricted to scripted lessons that close off discussion. Instructional tools and routines that seek widespread use by overspecifying behaviors and conversations in the classroom may help in meeting basic education goals, but they will not take us far toward the 21st-century star.

Many scholars and practitioners today recognize that to reap the benefits of more than half a century of cognitive research on thinking and mental capacity building will require serious attention to how education organizations function as well as to how individuals learn. Social science research has a long history of studying organizations. But systematic applications to education are more recent. And attempts to design education organizations and test those designs empirically in a continuous cycle of improvement are still rare. I hope the analysis and examples offered here will become part of a growing program of education improvement that brings the resources of cognitive science, sociocultural research, and organization theory and practice to bear on our efforts to reach for the star.

NOTE

This work was supported in part by the National Science Foundation ("Scaling Up Mathematics: The Interface of Curricula With Human and Social Capital," DRL-0228343) and the Pittsburgh Science of Learning Center, also funded by the National Science Foundation (SBE-0836012).

I wish to thank Elizabeth Rangel for her assistance, both substantive and editorial, in preparing this article.

1The term literate here refers not just to reading and writing but also to mathematics and basic knowledge in science, geography, and history.

REFERENCES


AERA Nominating Committee Seeks Recommendations for Nominees

The Nominating Committee invites AERA members to submit recommendations on prospective nominees for the office of President-Elect. The Committee will consider suggestions submitted by AERA members as part of its deliberation process to generate at least two nominees for the office.

A recommendation form appears below. The form must be signed by a current AERA member. All recommendations must be received by July 16, 2010. Note that current AERA officers (see AERA Council list, p. 356, this issue of Educational Researcher) are not eligible to succeed themselves in the same office.

I wish to make the following recommendation(s) to the AERA Nominating Committee:

For President-Elect:

Name: __________________________________________________________

Institutional affiliation: ____________________________________________

Member submitting recommendation(s):

Name (please print): ________________________________________________

Signature: _________________________________________________________

Contact information:

Institutional affiliation: ____________________________________________

Phone: ___________________________ E-mail: __________________________

Return to: Nominating Committee, c/o Phoebe H. Stevenson, Deputy Executive Director, American Educational Research Association, 1430 K Street NW, Suite 1200, Washington, DC 20005; Fax: (202) 238-3250.

Erratum


The name of Marlene J. Darwin, who was elected to the office of Chair of the School Turnaround and Reform SIG, was misspelled.