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Springing to Life

HOW GREATER EDUCATIONAL EQUALITY COULD GROW FROM THE COMMON CORE MATHEMATICS STANDARDS

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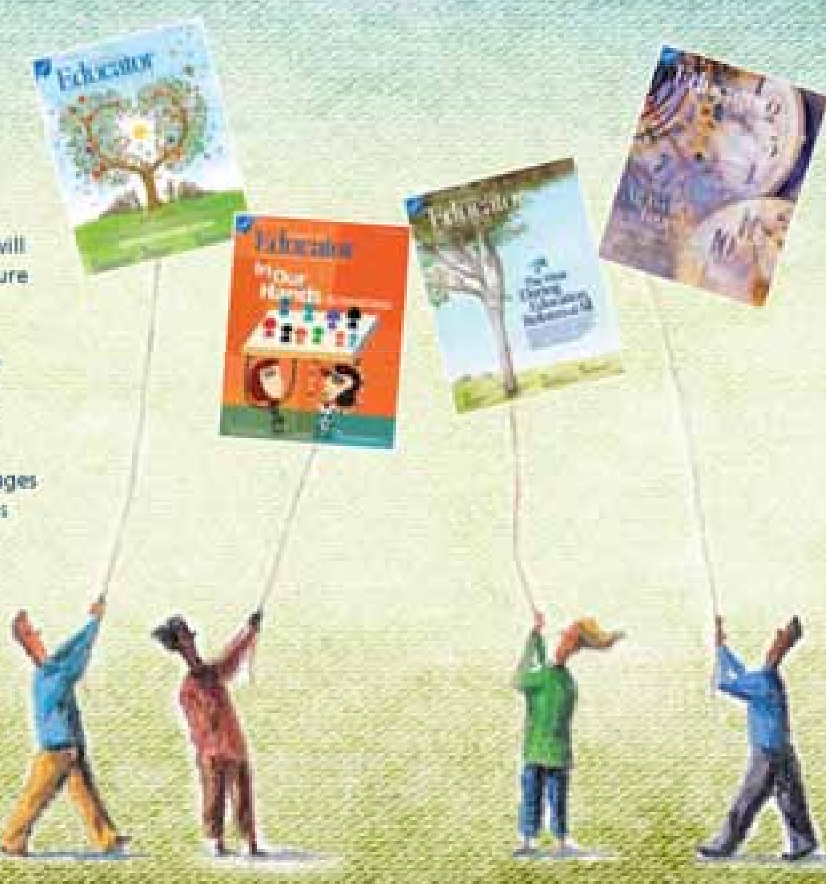
Fare Thee Well

It has been a great honor to serve as the editor of *American Educator* for the past five years. The AFT's family of educators, and their peers nationwide, are extraordinarily dedicated and talented—yet underappreciated by many of our nation's leaders. I have learned a great deal by listening to my AFT family, and I will recall and extend those lessons in my next venture as the communications director for the Core Knowledge Foundation.

Now it is my pleasure to announce *American Educator's* next editor: Amy Hightower. This is a coming home for Amy; she worked in the AFT's Educational Issues department from 2002 to 2007, and she coauthored an article for these pages in spring 2007. For the past several years, she has been the director of the Research Center for Editorial Projects in Education (the publisher of *Education Week*, *Quality Counts*, and other great resources). More importantly, her whole career has been dedicated to giving children a well-rounded, rigorous education. I wish Amy and the AFT continued success in supporting the nation's public schools.

Sincerely,
Lisa Hansel



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Springing to Life

How Greater Educational Equality Could Grow from the Common Core Mathematics Standards

By William H. Schmidt and Nathan A. Burroughs

In America, education has long been viewed as the main instrument for achieving equality of opportunity. Whatever our differences, the idea that every child deserves a chance to be educated enjoys widespread support. What has been contentious is how to go about promoting greater educational opportunities. Despite many reform efforts over the past several decades, the US educational system has patently failed to ensure equal access for all to the essential knowledge, skills, problem-solving abilities, and reasoning abilities that are necessary to succeed. Instead, American schools exhibit pervasive inequality.

Pervasive inequality. A bold claim, but that's the inescapable conclusion of more than 20 years of examining mathematics and science standards, student achievement, textbooks, standardized tests, and classroom content coverage. In mathematics, for instance, students are exposed to widely varying content not only across states and school districts but within schools. Such inequities in content coverage deny students equal learning opportunities. By the time they enter middle and high school, those students fortunate enough to have been challenged with rigorous, focused, and coherent content in the early grades are placed into courses that continue to challenge them, while their peers who were not

William H. Schmidt is a University Distinguished Professor, a codirector of the Education Policy Center, and the lead principal investigator of the Promoting Rigorous Outcomes in Mathematics and Science Education project at Michigan State University. He is a member of the National Academy of Education and a fellow of the American Educational Research Association. Nathan A. Burroughs is a research associate with the Center for the Study of Curriculum at Michigan State University.

ILLUSTRATIONS BY LIZA FLORES

exposed to such content are tracked into lower-level courses. And so the differences in learning opportunities that contribute to the achievement gap only continue to grow.

These problems aren't found only in our lowest-performing schools; the *typical* US student does not receive the content coverage needed to compete with students in other nations. While some may want to blame ineffective teaching or unmotivated students for the mediocre performance of US students on international assessments, research comparing states' standards (prior to the Common Core State Standards) with those of high-performing countries shows that a major factor is the lack of opportunity to learn. On average, our state standards have been about two grade levels behind.

Need more convincing? This body of research was examined in the Winter 2010–2011 issue of *American Educator* (see the box on page 5) and was explored in depth in a recent book, *Inequality for All* (see the box on page 6).

In this article, we move from demonstrating the existence of pervasive inequality to considering what to do about it. In particular, we examine the prospects for the Common Core State Standards for Mathematics (CCSS-M) to reduce inequalities in opportunity to learn. We discuss why the CCSS-M *could* provide greater equality of educational opportunity, and we offer some ideas about how to overcome the principal obstacles to successful implementation.

Inequality in Opportunity to Learn

Educational inequality has hardly gone unnoticed by policymakers, scholars, or the general public. In recent years, efforts to solve this problem have focused on the structure of education (high-stakes testing, market incentives, etc.) and the amount and distribution of educational resources. What actually happens in the classroom is at least as important but has received much less attention.

Exposure to academic content is a prerequisite to learning it. Children can hardly be expected to learn material they have never been exposed to, especially in mathematics. As a consequence, there is a strong relationship between the topics in which students are instructed and the knowledge they acquire. As just one example, our research team[*] has found that the rigor of mathematical content at both the district and classroom levels has a statistically significant relationship to student achievement, independent of student background.[1]

Pervasive inequality. That's the inescapable conclusion of 20 years of examining mathematics standards, student achievement, textbooks, tests, and classroom content.

In principle, every student ought to have the same opportunity to learn challenging mathematics content, but in schools, the content of instruction varies tremendously. Data drawn from the Third International Mathematics and Science Study (TIMSS) and the Promoting Rigorous Outcomes in Mathematics and Science Education (PROM/SE) project[†] demonstrate dramatic differences in the mathematics content offered in different states, school districts, and classrooms. Of these, the chief source of variation in instructional content occurs in the classroom, especially in eighth grade. In other words, what a student has a chance to learn varies not just between states and districts, but even within the same school at the same grade level. There are stark differences both in the content that is offered and the time spent on particular topics. Even classes with the same course title can offer very different content.[2]

This variation in topic coverage is usually exacerbated by tracking. All too often, low-performing students, who are disproportionately low-income and minority, are assigned to classes offering more elementary content. Rather than helping them catch up, such classes make it more likely that they will continue to lag behind their higher-performing peers.

Tracking may have fallen out of rhetorical fashion in recent years, but it remains a very common practice. Data from the National Assessment of Educational Progress (NAEP) indicate that three-quarters of eighth-graders and nearly a third of fourth-graders are assigned to mathematics classrooms on the basis of perceived ability. Given the greater likelihood that disadvantaged students will be assigned to weaker classrooms, the educational system is effectively reinforcing inequality rather than mitigating it.

These inequalities have very real consequences for individual students and for the nation as a whole. Workers who earn only a high school diploma and never go to college can expect to earn about 40 percent less than those who earn a bachelor's degree.[3] At the same time, a country with a better-educated workforce can expect to see greater long-term economic growth[4]—growth that depends on the skills not just of its managers and scientists but of all its workers.[5]

The Common Core and Overall Math Achievement

Recognition of the inequities and overall weakness of mathematics standards in the United States helped motivate one of the most ambitious educational reform efforts in recent decades: the Common Core State Standards for Mathematics (CCSS-M). Led by a coalition of state leaders, mathematicians, mathematics education researchers, and other stakeholders, the Common Core initiative aimed to establish high-quality mathematics standards that all states would choose to adopt. Common standards would move the

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*Key members of our research team include William H. Schmidt, Nathan A. Burroughs, Leland S. Cogan, Richard T. Houang, and Kathy Wight.

†To learn more about this project, see www.promse.msu.edu.

United States closer to what exists in most other countries.

What distinguishes the CCSS-M from previous efforts is the desire to make the new standards truly common, both within and among states. The CCSS-M have been adopted by 45 states and the District of Columbia, and are in the process of being implemented. A great amount of effort is going into developing common national assessments, with each state able to draw from a pool of items to create its own tests while preserving comparability across states. Ideally, the Common Core will ensure that all participating states possess high-quality standards and establish reasonable criteria for what students should be expected to learn.

To explore the CCSS-M's potential to improve overall math achievement, our research team has analyzed the relationship of the CCSS-M to the standards used by other countries and to the previous state standards, and studied whether states with standards closer to the CCSS-M had, on average, higher math scores.[6] Our first step was to analyze the CCSS-M's organization of topics in each grade. More than a decade ago,* our team did this same analysis of standards in other countries and identified three characteristics that distinguished the standards of the highest-achieving nations: focus, rigor, and coherence. Focus relates to the concentration on a few given topics in each grade so that students can learn for mastery—as distinct from the "mile-wide, inch-deep" curriculum common in the United States, where the same topics are covered shallowly from year to year. Rigor addresses at what grade level topics are covered. Coherence is concerned with matching the logical, hierarchical structure of mathematics with content coverage moving from more elementary topics in earlier grades to more sophisticated topics in later grades.

The second step was to compare the CCSS-M with these high-quality standards from high-achieving countries. Our statistical analysis revealed strong similarities, with roughly 90 percent of topics covered at the same grade levels and for the same number of grades. From an international standpoint, the CCSS-M appear to be high quality.

But are they better than states' previous standards? For the most part, yes. Our third step was to analyze the standards of all 50 states prior to the adoption of the CCSS-M. Verifying our previous work, we found considerable variation in state standards, with some quite similar to the CCSS-M and others quite different.

Finally, our research team explored the relationship between the proximity of a state's pre–Common Core standards to the CCSS-M and then looked at that state's average eighth-grade mathematics score on the 2009 NAEP. This simple comparison showed a reasonably strong relationship: the more similar the standards were to the CCSS-M, the higher student achievement. Adding layers of sophistication to our analysis, we did this comparison a few different ways, taking into account factors like how stringent a state's definition of proficient is and what percentage of students are from low-income families. Once these factors were considered, the relationship between NAEP performance and the closeness of states' standards to the CCSS-M was even stronger.

In sum, the evidence from both a US and an international perspective shows that the CCSS-M have the potential to improve average student achievement. The CCSS-M resemble the standards of high-achieving countries and exhibit the key features of coherence, rigor, and focus. Further, states with standards that resemble the CCSS-M did better, on average, on the 2009 NAEP.

The CCSS-M resemble the standards of high-achieving countries and exhibit the key features of coherence, rigor, and focus.

The Common Core and Inequality

Most of the public attention about the CCSS-M has concerned whether they represent better standards than the status quo, yet one of the key features of the new standards is that they are *common*. Because they have been adopted by nearly every state, some reduction in the differentiation across states seems inevitable. The creation of common assessments—which will increase comparability across states, districts, schools, and classrooms—should also reduce variation in content coverage within states, giving all administrators and educators much stronger incentives to ensure that all students have equitable opportunities to learn mathematics.

Although no full-scale empirical study can be conducted on the effect of the CCSS-M on educational inequality until they are fully implemented, we have some empirical evidence that these new standards could reduce it. Our research team has verified that (1) students in low-income school districts are generally exposed to less rigorous mathematical content, and (2) a stronger mathematics curriculum can reduce the relationship between socioeconomic status and achievement.[7] As a consequence, ensuring equal content coverage to low-income districts has the potential to improve student learning for underperforming groups who have thus far not been exposed to such focused, rigorous, and coherently presented mathematics.

This is no guarantee, of course. Opportunity to learn is only one

*For our early work comparing state standards with the standards in high-performing countries, see "A Coherent Curriculum: The Case of Mathematics," by William H. Schmidt, Richard T. Houang, and Leland S. Cogan, in the Summer 2002 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/summer2002/curriculum.pdf.

of several influences on student achievement. However, unlike community poverty or student background characteristics, the content of instruction is quite malleable. As such, policymakers have a special obligation to rectify the dramatic inequalities in what students have a chance to learn. Under the status quo, schooling is reinforcing background inequalities rather than ameliorating them. The CCSS-M, by attempting to provide more equal opportunities to learn, have the potential to reduce this one source of inequality.

Factors Influencing the Implementation of the CCSS-M

We have been very careful thus far to emphasize the Common Core's *potential* to reduce inequality and improve student achievement. Our restraint arises not only out of the habitual caution of researchers (particularly regarding any definitive statement that one thing clearly causes another), but also because of concerns about effective implementation of the new standards. The CCSS-M represent a fairly dramatic break with the status quo, and as such there are very real questions about whether there is sufficient commitment from policymakers and educators, and support from the public, to overcome barriers to the CCSS-M's progress.

I. Local Control of Curriculum

The first and most evident risk to the CCSS-M's realization is that they directly challenge the long-standing tradition of local control of the curriculum in American education—a structure that is itself one of the major factors related to educational inequality. Since their inception, each of the more than 15,000 local school districts has enjoyed wide latitude in curricular decision making. Incursions by other levels of government on local autonomy with respect to the curriculum, most especially by the federal government, usually have been met with skepticism at best and hostility at worst. Some quarters perceive the new standards as a transgression by the federal government against localism, as a "takeover" of education by national authorities. Even the recognition that the Common Core is a state-led initiative has not appeased all critics, in part because many state-led reform efforts also have aroused considerable opposition.

To some extent, the CCSS-M do not break with precedent: after all, every state has educational standards laying out (with varying specificity) expectations for grade-level content coverage. But these standards have not typically been realized.[8] Far too many states seemed to think that adopting standards and buying loosely aligned tests were all that was needed to join the standards-based reform movement. If the CCSS-M are treated the same way, then we can expect them to have little impact on either student achievement or inequality.

The Common Core does remove responsibility for one piece of educational policy from local school districts. If the CCSS-M were fully implemented, school districts would no longer be responsible for deciding what mathematics topics would be taught to students each year. However, it must be made clear that leaving curricular decision making up to local school districts is a major contributor to educational inequality. As it stands now, students' chances to learn challenging content depend on whether they are lucky enough to attend a school that provides it. In effect, a defense of localism in questions about content amounts to a defense of inequality in opportunity to learn.

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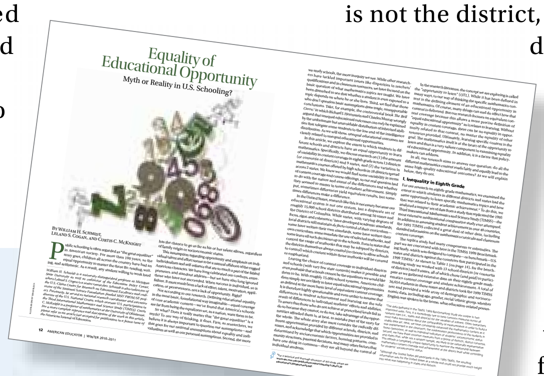
II. Teachers

Whether districts embrace the CCSS-M or not, we must also question how much of today's curricular decision making really is in the hands of school district administrators, or even principals. Statistical analyses suggest that the greatest source of variation in instructional content—by an overwhelming 80 percent or more—is not the district, or the school, but the classroom. Whatever district curriculum guides or state standards call for, as a practical matter teachers decide what is taught in their classrooms.

Some critics of the CCSS-M suggest that the new standards impose on teachers, stripping them of hard-won professionalism at a time when so many educators feel under siege by budget cuts and other reform efforts. However, we question the degree to which teachers should really want to be responsible for deciding what topics they will teach. Because most states have not taken implementation of their pre–Common Core standards seriously, teachers have been forced to act as content "brokers." They have had to pick and choose among competing signals about what to teach from poorly aligned state assessments, textbooks,



Equality of Educational Opportunity

Myth or Reality in U.S. Schooling?

By William H. Schmidt, Leland S. Cogan, and Curtis C. McKnight

For more on the dramatic differences in content coverage across classrooms, schools, districts, and states, see "Equality of Educational Opportunity," by William H. Schmidt, Leland S. Cogan, and Curtis C. McKnight, in the Winter 2010–2011 issue of *American Educator*, which is available for free at www.aft.org/pdfs/americaneducator/winter1011/Schmidt.pdf.

state standards, district-mandated standardized tests, and (if they are lucky enough to be in a district that offers any guidance) district curriculum guides. But teachers are not necessarily trained content experts, and they shouldn't be expected to make these decisions. In elementary grades, they are usually generalists, and many have only a limited background in each of the subjects they must teach. In later grades, even if they are mathematics specialists (usually the case in middle and high school), the chief orientation of many teachers is not in selecting content but in developing the skills needed to help students learn.*

It cannot be said often enough that the CCSS-M only address what topics should be taught, not *how* they should be taught: pedagogy is absent from the Common Core. In fact, freed from their role as content brokers, teachers will be able to focus on tailoring their instruction to the needs of their particular students. And, by reducing the number of topics that students are expected to learn, the CCSS-M also give teachers more time to prepare and carry out rich lessons. Another advantage of the CCSS-M is that they open up the possibility for cross-classroom and cross-grade collaboration by teachers, allowing them to teach for mastery, share lesson plans, provide long-term support to struggling students, and track each student's learning trajectory.

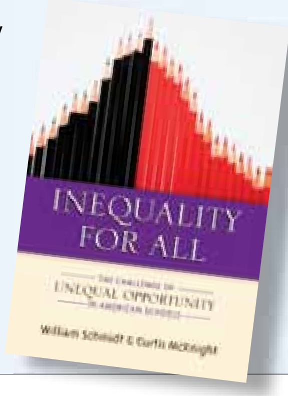
However, research suggests that, without support, many teachers will find it challenging to develop the deeper mathematics knowledge called for in the CCSS-M. Surveys of teachers in Ohio and Michigan conducted as part of PROM/SE indicated that a majority of elementary mathematics teachers did not feel well prepared to teach all of the mathematics topics included in the CCSS-M, either in their own or later grades. Likewise, the US sample of the Teacher Education and Development Study, which included nearly 3,300 future teachers from 81 preparatory institutions, showed that US teachers were in the middle of the interna-

*Even if most teachers did have such content expertise, the act of selecting which topics to teach and organizing them across grades simply cannot be done in isolation. It must be coordinated across grades—and since many children move frequently, it must be coordinated across schools.

Inequality for All

For a detailed look at variations in mathematics and science content across the country, see *Inequality for All: The Challenge of Unequal Opportunity in American Schools*, by William H. Schmidt and Curtis C. McKnight. Schmidt and McKnight have been working for more than two decades to identify and understand differences in mathematics and science achievement across developed countries and in the United States. From standards to textbooks to classroom-level content, they have tracked the many ways that students do not receive equal opportunities to learn the core content that is essential to thriving in modern society.

These scholars not only provide overwhelming evidence of inequities, they also offer a thoughtful look at how the Common Core State Standards could be the beginning of a more equitable education system. Implemented well, these standards will provide teachers with sound guidance on essential content and flexibility in how to support students as they learn that content. Schmidt and McKnight emphasize equitable—not identical—learning opportunities. As they write, "educational contexts differ, and providing the same content in the same way would not necessarily secure equal opportunities to learn for different students."



Schmidt and McKnight are fine writers, so we leave it to them to invite you to read more. Here are the first two paragraphs of their important book:

> This is a story about schooling in America and, thus, a story about children—the nation's greatest resource. It is also, at a more personal level, a story about our own children. We know that the content, skills, reasoning ability, and problem solving children develop in school are important both to their future and to the nation's; every country in the world understands this. However, in the United States, one of the wealthiest and most democratic nations on earth, the reality is that the opportunities many children have to acquire such knowledge—especially in mathematics and science—are not guaranteed. As they walk into school, children become players in a game of chance, one that is dangerously invisible to both child and parent, and one with very high stakes. Sadly, therefore, this story has no fairy-tale ending.
>
> The opportunities of too many students are arbitrarily determined by factors outside of their control, such as the state and local community where they live, the school they attend, the teacher they have, the textbooks the school has purchased, and the tests they must take. There are no villains in this story; everyone acts with the best of intentions, if not always with the greatest of wisdom. All of these factors conspire to create a very inconsistent and uneven system, one in which chance plays a major role and, as other countries have demonstrated, chance has no place in the education of children. The telling of this as a story is not just a literary device to make a more abstract point; it is, at its most basic level, a real story about real children.

–EDITORS

tional distribution, and that future middle school mathematics teachers took fewer mathematics courses than did those in higher-achieving countries.[9] In short, there is reason to believe that major investments in mathematics professional development and pre-service teacher preparation will be necessary in order for teachers to be fully prepared to teach the CCSS-M.

III. Textbooks

Considerable pressure is on textbook publishing companies, which must quickly develop materials compatible with the CCSS-M. US textbooks have long been problematic; much longer and less focused than those used in other countries, they implicitly encourage teachers to teach all topics in a fairly summary fashion (a feature of the "mile-wide, inch-deep" phenomenon). Unfortunately, textbooks serve as a key intermediary between the standards and classroom teaching.[10] Inexperienced and underprepared teachers often rely on the materials provided by textbooks, and in some cases even follow them literally, as some school districts expect their teachers to do, beginning on page 1 and moving in strict accordance with the book. Better prepared and more experienced teachers may recognize the problems with their textbooks and, when permitted, may reorganize the material presented in the textbook or search for supplementary materials. Textbooks thus play a key role in the implementation of any standards, including the Common Core.

Given the new approach of the CCSS-M and the relatively short time available, textbook publishers will be strongly tempted to simply issue supplementary guides or to rearrange their old books and label them "aligned with the Common Core." Either of these would make implementing the new standards more difficult, since teachers are already likely to hesitate before removing any topics they previously taught, fearing students will not learn the material elsewhere. From what we have seen so far, policymakers, educators, and parents will need to put an enormous amount of pressure on textbook publishers, demanding new books written from scratch for the CCSS-M.[†]

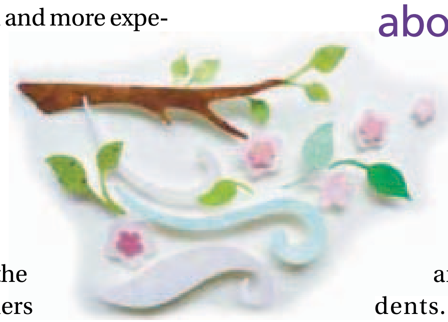
IV. Assessments

The adoption of the CCSS-M will also necessitate entirely new assessments. Because states continue to rely on high-stakes testing as a strategy for educational reform, Common Core–aligned assessments are in the process of being created. Two assessment consortia—the Partnership for Assessment of Readiness for College and Careers (PARCC) and the Smarter Balanced Assessment Consortium—are developing these new tests. Not only must a range of new items be piloted in a very short time, but one of the consortia has also decided to use a computer-adaptive model of testing, which invites a number of challenges. For example, schools will have to be equipped with and trained to use computers capable of running these assessments, which is difficult in a time of restricted budgets. Like revamping textbooks, the assessments should mainly be a transitional problem. Assuming that time and resources are forthcoming, there is every reason to expect adequate assessments can be put into place.

V. Parents and Voters

Last but not least, the attitudes of parents and voters toward the Common Core are crucial for long-term sustainability. The development and adoption of the CCSS-M has been led by state governments—not by a popular outcry demanding common standards. Implementing any new policy comes with an opportunity cost; selecting the CCSS-M as a high priority inevitably comes at the expense of other educational (and noneducational) efforts, both in terms of resources and personnel. Teachers and administrators will have to explain the new standards to parents, and in particular how they will affect students. Whether as parents or as voters, the response of the general public ultimately will determine the viability of the Common Core.

A defense of localism in questions about content amounts to a defense of inequality in opportunity to learn.



What Stakeholders Think about the Common Core

In the previous section, we laid out the principal threats to the CCSS-M's implementation. All of these concerns are somewhat speculative, however. What we really need are facts. To establish a baseline on key stakeholders' attitudes toward the Common Core, in 2011 we commissioned nationally representative surveys of curriculum directors, teachers, and parents.

We surveyed nearly 700 curriculum directors of local school districts in the 41 states that had adopted the Common Core at the time, with representative samples in each state. The good news: nearly all of those questioned had heard of the Common Core and knew their state had adopted the new standards. Despite concerns by some that the Common Core might threaten the autonomy of school districts, nearly all (90 percent) of those surveyed supported the new standards. Strong majorities of the curriculum directors believed that the CCSS-M provided clear goals for what students needed to learn, were of high quality, would improve student achievement, would help teachers, and would promote more-equal opportunities. Curriculum directors, though, did identify a major risk to successful implementation: the lack of assessments, textbooks, and other instructional materials properly aligned with the CCSS-M. As we mentioned earlier, although very real, these obstacles to implementation hopefully are *transitional* rather than *fundamental*.

Now the bad news: a majority of curriculum directors thought

[†]For more on the problems with textbooks, see "Phoenix Rising: Bringing the Common Core State Mathematics Standards to Life," by Hung-Hsi Wu, in the Fall 2011 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/fall2011/Wu.pdf.

the new standards were basically the same as the previous state standards—something our research team has found is only true in a few states.[11] Only about a quarter of curriculum directors thought the Common Core standards were substantially different from the content provided in their own districts. In addition, when asked to describe what topics their districts taught at each grade, respondents indicated a very large variation in content coverage across school districts, even within the same state. In short, although curriculum directors support the Common Core, we question how well they understand the new standards and the magnitude of the task ahead.

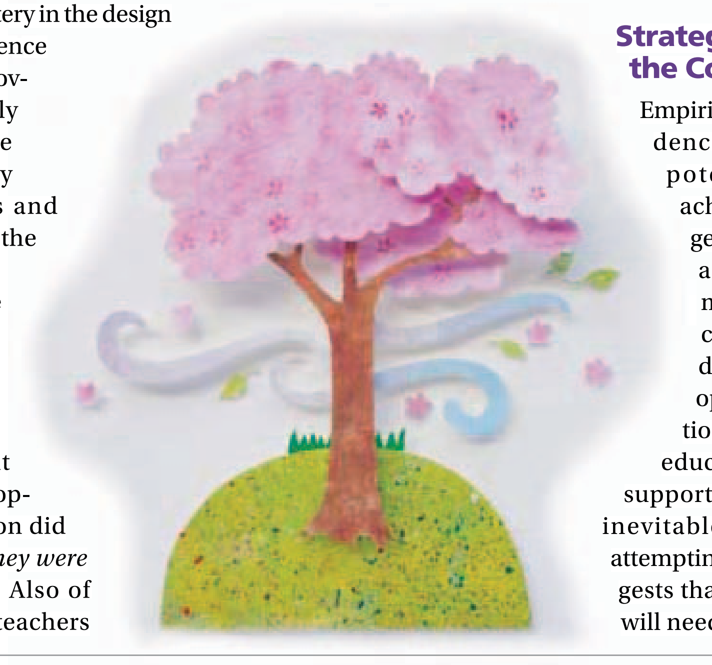
The sample for the teacher survey comprised more than 12,000 respondents in the same 41 states as the curriculum directors' survey, with a mix of elementary, middle, and high school teachers. As with the curriculum directors, the vast majority of teachers had some familiarity with the CCSS-M, varying somewhat by state. Over 80 percent stated that they had read the standards for their grade. A preponderance of teachers thought the CCSS-M were similar to the previous standards (77 percent) and said they liked the new standards and would teach to them (94 percent). The quality of the CCSS-M and more-equal opportunities were the most cited reasons for supporting the Common Core.

The questions targeted specifically to teachers point to several potential pitfalls. When asked what they needed to implement the CCSS-M, most named professional development and other forms of support. Teachers cited a lack of properly aligned textbooks and assessments, and concerns about parental support, among the potential obstacles to implementation. Further, questioned about which topics they currently teach, roughly 80 percent of teachers are teaching topics that are aligned appropriately with the CCSS-M, but about 40 percent also are teaching topics that the CCSS-M assign to a different grade level. This result is reason for concern, since about a quarter of teachers said they would refuse to drop a topic that they currently covered but that the CCSS-M recommend be skipped, while a majority were unsure. Given the centrality of teaching for mastery in the design of the CCSS-M, teachers' ambivalence about narrowing their content coverage is troubling. We can only hope that teachers will be more willing to drop topics once they better understand that focus and coherence are key attributes of the CCSS-M.

An even greater issue is the lack of teacher confidence in teaching CCSS-M topics. Depending on the grade level, somewhere between 25 percent and 37 percent of teachers felt unprepared to teach CCSS-M topics, and a substantial proportion did not feel well prepared *even if they were already teaching those topics*. Also of concern: only about a third of teachers (35 percent) had thus far participated in professional development for CCSS-M, and just a fifth (20 percent) in textbook reviews for CCSS-M. At the time of the survey, 35 percent of teachers had not participated in any preparation for the CCSS-M whatsoever. It might be that the pace of implementation efforts by districts and schools increased during 2012, but the lack of early planning could make the transition to the CCSS-M difficult for some districts.

Finally, our survey of parents covered all 50 states. We found that though awareness of the CCSS-M has increased in the last year, even after a brief description, only a bare majority had heard of them and very few knew whether their state had adopted them. Despite the lack of publicity about the CCSS-M, more than two-thirds of parents supported common national standards in mathematics. Strong majorities (roughly 80 percent) thought that all elementary and middle-grades students should be exposed to the same mathematics content, across states, school districts, and classrooms. Teachers' fears that parents would not support higher standards may be misplaced: substantial majorities of parents said that they supported more-demanding math, even if it required more studying, more homework, or their child struggling early on. When it comes to mathematics, there is a strong appetite among parents for common, rigorous content standards.

Substantial majorities of parents said they supported more-demanding math, even if it required more studying, more homework, or their child struggling early on.



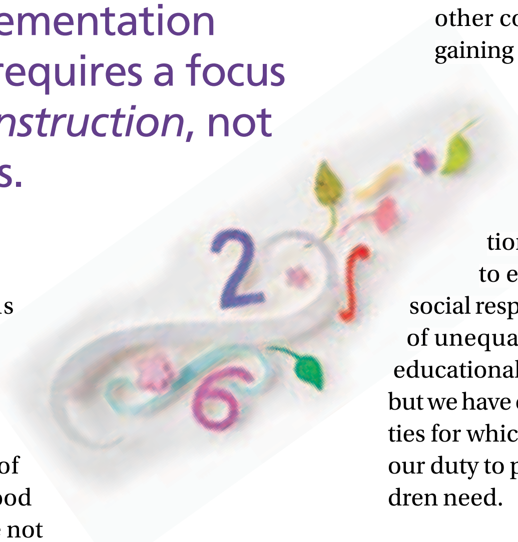
Strategies for Implementing the Common Core

Empirical research provides some evidence that the CCSS-M have the potential to increase student achievement. Survey results suggest that stakeholders are open to adopting common standards in mathematics to improve the competitive position of US students and to foster more equal opportunities to learn. The question is whether policymakers and educators will capitalize on public support and successfully manage the inevitable obstacles that arise when attempting major changes. Research suggests that teachers and administrators will need a great deal of support if they are to realize the new standards. Because of budgetary constraints and competition from other reform efforts, educators and district personnel need cost-effective methods for preparing teachers and aligning instructional materials. At the end of the day, successful implementation of the CCSS-M requires a focus on changes in *instruction*, not just assessments.

To aid this effort, our research team has begun to develop tools that might prove useful in implementing the new standards. These tools are not the be-all and end-all of reform efforts (and, unfortunately, these tools will not be available to educators outside our research projects in the foreseeable future). We describe them only as an example of the kinds of technologies and strategies necessary if the CCSS-M are to have a chance to succeed. There is a tremendous need for innovative thinking about the challenge of aligning day-to-day mathematics instruction to the CCSS-M.

First, we are developing an online tool to help teachers align their instructional materials (including textbooks) with the CCSS-M. In previous research, we analyzed the mathematics instructional materials of a cross section of school districts. Textbooks stood out as problematic. Most were not well aligned to the CCSS-M. Each CCSS-M topic tended to be distributed throughout the textbook rather than being combined—they lacked coherence. In addition, textbooks covered a great deal of material that was not part of the CCSS-M—they lacked focus. Some important topics were not even covered at all. Realizing that revised textbooks will not be available soon (because of both publishers' resistance and states' and districts' budget problems), we are developing an online tool for teachers to map their textbooks onto the CCSS-M. A number of textbooks have been coded so that lessons are matched with CCSS-M requirements, making it much easier for teachers to modify the sequence and amount of instruction focused on any given topic. So far, our research suggests that this approach holds promise.

Successful implementation of the CCSS-M requires a focus on changes in *instruction*, not just assessments.



Second, as part of a research study of early CCSS-M implementation efforts, we provided teachers in selected districts with an online tool to track which mathematical topics they had covered each day. Teachers were asked to record the content covered, amount of time devoted to each topic, materials used, and mathematical practices used, as well as how prepared the teacher felt to teach each topic. A key feature was that the topics presented in the online tool were explicitly matched with the CCSS-M. What began as a means for tracking the content of instruction soon became something rather different. Through feedback from teachers, we learned that the daily act of recording how their topic coverage matched the CCSS-M made them much more familiar with the standards and actually altered the pattern of instruction. Many teachers found that they were teaching topics well ahead of or behind what the CCSS-M called for. In a spontaneous process, teachers began sharing insights with one another, seeking greater understanding of the CCSS-M and modifying their patterns of topic coverage. We are now in the process of building on these findings to develop an intervention that uses the online topic tracking system as a relatively low-cost professional development tool.

The Challenge of Inequality

Public education is widely considered one of the keys to economic prosperity and social stability in the United States. Until very recently this country boasted the world's best-educated population, and this human resource helped the United States take full advantage of its natural resources. Today, as other countries have outstripped us educationally and are gaining on us economically, we must address the inequalities inherent in the structure of US education.

The CCSS-M represent an opportunity to address this inequality. We as a nation created unequal learning opportunities with our fragmented curriculum, inadequate teacher preparation, and low-quality instructional materials. If we fail to effectively implement the CCSS-M, we abdicate our social responsibility and become complicit in the perpetuation of unequal opportunities. The CCSS-M will not eliminate all educational inequalities or guarantee a fair chance to everyone, but we have concrete evidence that they may reduce those inequities for which we, as a society, are most acutely responsible. It is our duty to provide the equitable learning opportunities all children need. ☐

Endnotes

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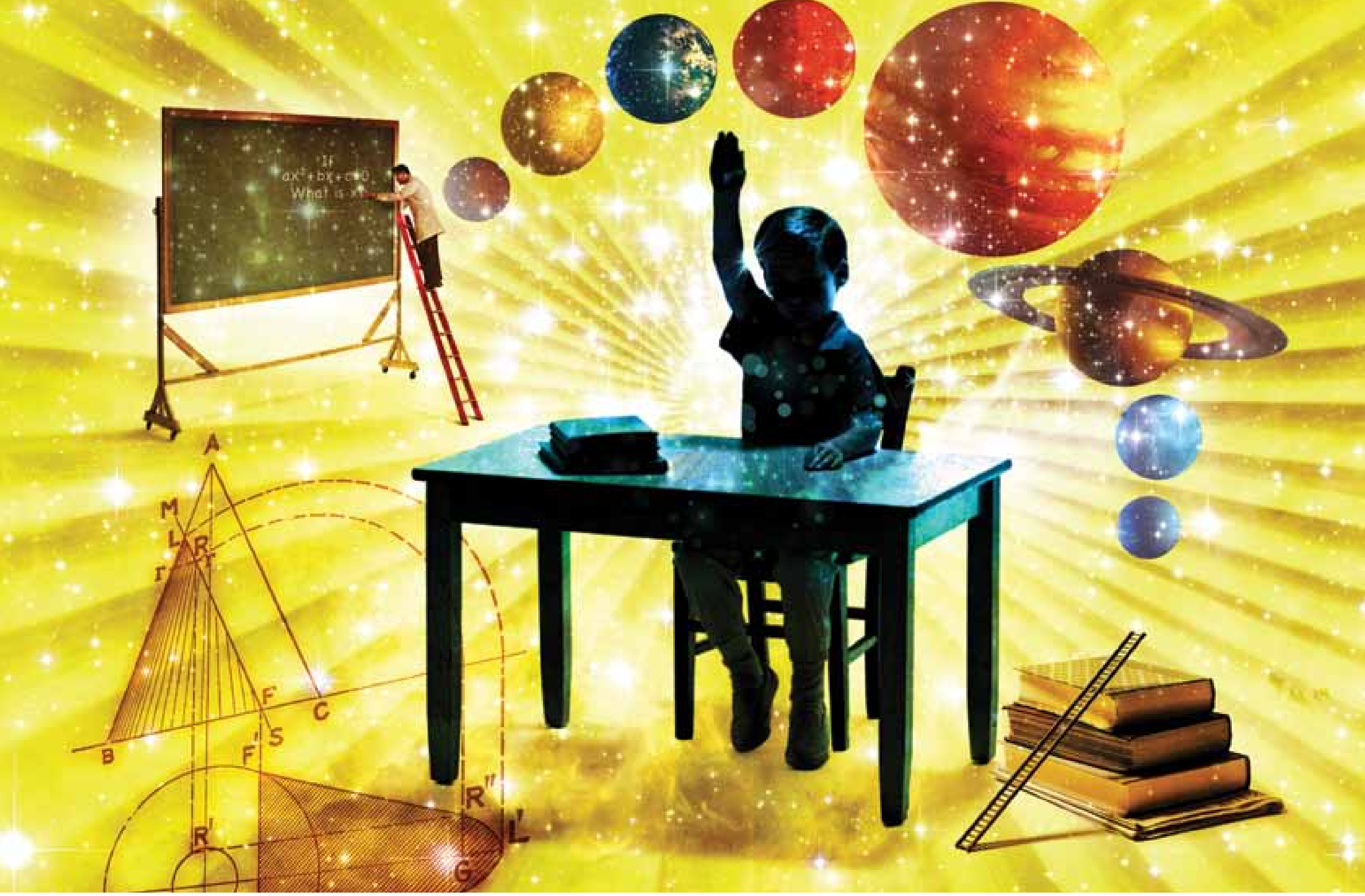
Schooling Makes You Smarter

What Teachers Need to Know about IQ



ILLUSTRATIONS BY WILLIAM DUKE

BY RICHARD E. NISBETT

In 1994, America took a giant step backward in understanding intelligence and how it can be cultivated. Richard Herrnstein, a psychology professor at Harvard University, and Charles Murray, a political scientist with the American Enterprise Institute, published *The Bell Curve*, a best-selling book[1] that was controversial among researchers, but was given enormous, uncritical attention in the popular press. It would be difficult to overestimate the impact of *The Bell Curve*. Even people who never read the book picked up its conclusions from press accounts and from discussions with people who read it. The impact on policymakers was substantial, and many practicing educators today accept the views about intelligence presented in the book and fostered by the media.

The conclusions that many people drew from the book were that IQ tests are an accurate and largely sufficient measure of intelligence, that IQ is primarily genetically controlled, that IQ is little influenced by environmental factors, that racial differences in IQ are likely due at least in part, and perhaps in large part, to genetics, and that educational and other interventions have little impact on IQ and little effect on racial differences in IQ. *The Bell Curve* encouraged skepticism about the ability of public policy initiatives to have much impact on IQ or IQ-related outcomes.

But in fact, *all of the conclusions I have just summarized are*

Richard E. Nisbett is the Theodore M. Newcomb Distinguished University Professor at the University of Michigan, a research professor with the university's Institute for Social Research, and a codirector of its Culture and Cognition Program. He was elected to the National Academy of Sciences in 2002 and has earned numerous professional accolades, including the Distinguished Senior Scientist Award from the Society of Experimental Social Psychology, the Distinguished Scientific Contribution Award from the American Psychological Association, and a John Simon Guggenheim fellowship. He has written several books, including Intelligence and How to Get It: Why Schools and Cultures Count. *Large portions of this article are adapted with permission from "Intelligence: New Findings and Theoretical Developments," by Richard E. Nisbett, Joshua Aronson, Clancy Blair, William Dickens, James Flynn, Diane F. Halpern, and Eric Turkheimer, published in the February–March 2012 issue of* American Psychologist.

mistaken. Even at the time the book was published, many cognitive scientists believed that some of these conclusions were erroneous.[2] Now we know that all of them are. In this article, I will describe the new knowledge that is most relevant to educators. The basic conclusions are that environmental factors are much more important in determining intelligence than previously believed, that racial group differences owe little or nothing to genes, and that interventions, including school, influence intelligence at every level from prenatal care to college and beyond.

To begin, let's take a look at what intelligence and IQ are. My working definition of intelligence is the one offered by Linda Gottfredson, a professor at the University of Delaware:[3]

> [Intelligence] involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings—"catching on," "making sense" of things, or "figuring out" what to do.

The measurement of intelligence is one of psychology's greatest achievements, and one of its most controversial. Critics complain that no single test can capture the complexity of human intelligence, all measurement is imperfect, and no single measure is completely free from cultural bias; they also point out that there is the potential for misuse of scores on tests of intelligence. There is some merit to all these criticisms. But the measurement of intelligence is extremely useful because it is a reasonably good predictor of grades at school, performance at work, and many other aspects of success in life.

The chief measure that I focus on in this article is IQ because the bulk of evidence pertinent to intelligence comes from IQ tests. IQ stands for "intelligence quotient" because originally the index was "mental age" divided by chronological age. IQ tests provide a way of evaluating an individual's cognitive capacities relative to others of the same age. Today's widely used IQ tests, such as the Stanford-Binet and Wechsler, are considered valid because they are strongly related to real-life outcomes. For example, IQ, SAT, and ACT scores are all highly correlated,[4] and students who score higher on tests such as the SAT and ACT tend to perform better in school than those who score lower.[5] Similarly, people in professional careers, such as attorneys, accountants, and physicians, tend to have high IQs. Even within professions, those with higher IQs outperform those with lower IQs on average, with the effects of IQ being largest for those occupations that are most demanding of cognitive skills. It's important to remain vigilant for misuse of scores on tests of intelligence or any other psychological assessment, and to look for possible biases in any measure, but intelligence test scores remain useful when applied in a thoughtful and transparent manner.

One of the most important uses is in developing interventions; measuring intelligence is essential to figuring out how to increase it. Some group differences in IQ are large, and much evidence indicates that it would be difficult to overcome a broad array of racial disparities if IQ differences could not be ameliorated. IQ tests help us to track the changes in intelligence of different groups (and of entire nations) and to determine if interventions intended to improve intelligence are working.

Although this article focuses on findings from the hundreds of high-quality studies done with IQ tests, types of intelligence other than the analytic kind examined by IQ tests certainly have a reality—and researchers are working to learn more about them. For example, Robert Sternberg, the provost of Oklahoma State University, and his colleagues have studied *practical intelligence*, which they define as the ability to solve concrete problems in real life that require searching for information not necessarily contained in a problem statement, and for which many solutions are possible. They have also studied *creativity*, or the ability to come up with novel solutions to problems and to originate interesting questions.[6] Sternberg and his colleagues maintain that both practical intelligence and creativity can be measured, that they correlate only moderately with analytic intelligence as measured by IQ tests, and that they can predict significant amounts of variation in academic and occupational achievement over and above what can be predicted by IQ measures alone. Measures of curiosity also predict school grades above and beyond the degree of predictability that can be attained by IQ tests.[7]

Interventions, including school, influence intelligence at every level from prenatal care to college and beyond.

Some widely known examples of different types of intelligence come from Howard Gardner's theory of multiple intelligences. I don't doubt that the kinds of intelligence he has proposed—bodily-kinesthetic, musical, spatial, etc.—are genuine and can be important in specific domains of life.[8] The same is true for emotional intelligence and social intelligence. But none of these more specific intelligences have been shown to predict school success or career attainment above and beyond their association with general intelligence. Such predictive value might be found in the future, but for now the bulk of evidence pertinent to intelligence comes from IQ tests.

Let's take a closer look at what those tests measure.

IQ Tests Measure Two Types of Intelligence

IQ tests measure two types of intelligence: crystallized and fluid. *Crystallized intelligence* refers to the individual's store of knowledge about the nature of the world. This includes vocabulary, information, and comprehension of the way the world works as shown by answers to questions such as "why are houses on a street numbered consecutively?" It also includes learned skills such as arithmetic.

Fluid intelligence consists of the ability to solve novel problems that depend relatively little on stored knowledge, as well as the capacity to learn (i.e., the capacity to store knowledge in long-term memory). Fluid intelligence depends on the capacity of one's working memory (the mental "space" in which thinking occurs), as well as the extent of one's attention control (ability to focus on the most important aspects of a problem) and inhibitory control (ability to suppress tempting but irrelevant actions).

A test that is widely considered the best available measure of fluid intelligence is Raven's Progressive Matrices. This test requires examination of a matrix of geometric figures that differ from one another according to a rule to be identified by the individual being tested. This rule is then used to generate an answer to a question about what new geometrical figure would satisfy the rule. The figure below shows a sample item like the Raven's test.

In nations that were fully modern by the beginning of the 20th century, IQ has increased by about 3 points per decade from the end of World War II to the present.

The example that the problem solver must follow is set up by the two figures on the top in the left panel. The figure at the left on the bottom then specifies what has to be transformed in order to solve the problem. The problem solver must choose an answer from the six figures on the right.

Solving the problem requires that you notice that the top and bottom figures on the left of the panel are diamonds, and the figure on the upper right is a square. This tells you that the answer has to be a square. Then you must notice that the lower half of the diamond on the upper left is divided in two, with the left portion in black. The fact that the corresponding portion of the square on the right is also black tells you that the same must be true in the answer square. That's the entire bottom half. Comparing the bars in the upper diamond and square, you notice that one of the bars has been removed from the square while preserving the symmetry of the bars. Since the diamond on the lower left has two bars, this establishes that the answer square must have one centered bar. Now you know that the correct answer must be the square at the bottom right of the answer panel.

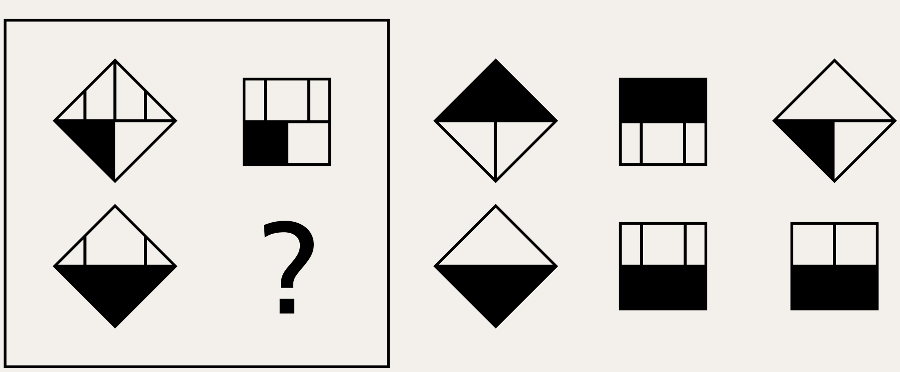
Crystallized intelligence and fluid intelligence are very different aspects of intelligence. Much evidence points to this conclusion; here is a brief summary of the key findings: 1) Fluid intelligence is mediated by the prefrontal cortex (PFC)—the part of the brain just behind the forehead. Crystallized intelligence is mediated by a wide variety of different structures in the brain. 2) Fluid intelligence declines from early adulthood on. Crystallized intelligence actually keeps growing until old age. 3) The PFC deteriorates with age more rapidly than the rest of the cortex does, which makes sense given that fluid intelligence diminishes more over time than does crystallized intelligence. 4) Changes in fluid intelligence and crystallized intelligence across the teenage years can be substantial, and those changes are independent of one another and are associated with changes in gray matter in different parts of the brain.[9] 5) Severe damage to the PFC is associated with marked impairment of fluid intelligence but little or no impairment of crystallized intelligence. 6) Severe impairment of crystallized intelligence, such as occurs in autism, is sometimes associated with near-normal or even superior fluid intelligence. 7) Crystallized intelligence can be increased by techniques that have no effect on fluid intelligence and vice versa.

For educators, the most important point in this description of fluid and crystallized intelligence is that both can be increased. In fact, they have increased substantially over the past several decades.

The Flynn Effect: Massive Gains in Population IQ Over Time

Americans' average years of schooling have increased from a median of 8 in 1910 to a median of 14 in 2010. If school makes you smarter, then we ought to have gotten noticeably smarter in the last century. And, indeed, we have gotten smarter—a lot smarter. The citizens of all developed countries have gotten smarter, in fact. James Flynn, an emeritus professor at the University of Otago in New Zealand, reports that, in nations that were fully modern and industrialized by the beginning of the 20th century, IQ has increased by about 3 points per decade from the end of World War II to the present.[10] That amounts to a gain of 18 points, which is equivalent to moving from a 50th percentile score (IQ equal to 100) to a score at the 93rd percentile (IQ equal to 118). (The actual mean IQ has been static at 100 because the tests are revised every few years, making them more difficult, so that the convenient mean of 100 can be maintained.) In nations that began to modernize during the early to mid-20th century,

A problem similar to those on the Raven's Progressive Matrices test



SOURCE: JAMES R. FLYNN, *WHAT IS INTELLIGENCE? BEYOND THE FLYNN EFFECT* (NEW YORK: CAMBRIDGE UNIVERSITY PRESS, 2007). REPRINTED WITH PERMISSION.

the increase in IQ began somewhat later, but now they are also on track to gain 3 or more points per decade. Nations that have only recently begun to modernize, such as Kenya, Sudan, and the Caribbean nations, have begun to show extremely high rates of gain.

The causes of these IQ gains are debated. Almost surely, increased schooling has contributed to the difference, and almost equally surely, improvements to the curriculum have contributed. For example, some skills that could be expected to improve performance on the Raven's test of fluid intelligence, such as analyzing and making comparisons among shapes, are now taught in kindergarten. At the same time, society has become more complex in every way, making ever greater demands on intelligence. The culture has changed to meet those demands. Computer games, some of which have been shown to improve working memory and other executive functions that underlie fluid intelligence, provide one example.

A child with a bigger vocabulary is a child with more concepts to work with—and therefore really is smarter.

IQ has increased, but has *intelligence* really increased? Some IQ experts, and many laypeople, would say no. But a look at IQ subtests is enough to convince me that we really have gotten smarter in some respects. A child who can tell you why houses are numbered consecutively, or why doctors go back and get more education, is smarter than a child who can't tell you these things. A child with a bigger vocabulary is a child with more concepts to work with—and therefore really is smarter. A child who can tell you how revenge and forgiveness are alike is smarter than a child who draws a blank on that question. And today's children have improved greatly in all these respects, as compared with children a few decades ago.

The fact that IQ has increased so much is enough by itself to establish that intelligence is highly modifiable.

Genes and the Environment

Several strands of evidence suggest that the effects of genes on intelligence, though undeniable, are not nearly as determinative as hereditarians (like the authors of *The Bell Curve*) misbelieved, or environmentalists feared, 25 years ago. Let's start with an example. Height within a given population is 90 percent heritable. That is to say, 90 percent of the height variation in the population is due to genetic differences. Between 1979 and 2009, the average height of male South Korean high school seniors increased so much that a boy with average (i.e., 50th percentile) height in 1979 would have been far below average (at about the 10th percentile) in 2009.[11] Korean male height in 1979 was 90 percent heritable and Korean male height in 2009 was 90 percent heritable, but environmental factors such as nutrition and health practices nevertheless had a massive effect on height. This is similar to the Flynn effect discussed earlier. The crucial point both of these examples make is that a characteristic can be mostly heritable, yet still be hugely influenced by the environment. Heritability places no limits on modifiability.

When talking about IQ, people frequently assume that heritability reflects the proportion of a person's intelligence that is genetically determined. This belief is quite mistaken. In fact, it's nonsensical. There could never be a way of determining what fraction of an individual's intelligence is inherited and what fraction is environmentally produced. Heritability of a characteristic refers to *the proportion of variation in the characteristic in a given population that is accounted for by genes*.

The heritability of a trait depends on the relative contributions of genetic makeup and environment. The concept of heritability has been influenced by animal breeding experiments, where variations in genetic makeup and environment are under the control of the experimenter, and under these conditions, the concept has some real-world applications. In free-ranging humans, however, variability is uncontrolled, there is no "true" degree of variation to estimate, and heritability can take practically any value for any trait depending on the relative variability of genetic endowment and environment in the population being studied. In any naturally occurring population, the heritability of intelligence is not zero (if genetic makeup varies at all, it will be reflected in IQ scores), and it is not 100 percent (if environment varies at all, it will be reflected in IQ scores). This said, most studies estimate that the heritability of IQ is somewhere between 40 and 80 percent.

Research on socioeconomic status (SES) and IQ highlights just how much heritability of IQ can vary—and just how important the environment is. Most of the variation in intelligence for children from higher-SES families is explained by genes. Most of the variation in intelligence for lower-SES families is due to environmental differences. In some studies, the heritability of IQ for upper-middle-class children was as high as 70 percent, and the heritability for lower-class children was as low as 20 percent.[12]

Why should genes be more important to variation in IQ of higher-SES children than of children who are worse off? The environments of higher-SES families are usually very favorable for increasing the intelligence of children and, more importantly for heritability, those environments probably don't differ much from one another. The environment of Doctor Smith's family doesn't differ much from the environment of Lawyer Jones's family in the factors that support intellectual growth. When environments don't differ much, the differences between children's IQs have to be largely due to genetic factors.* The environments of lower-SES families, in contrast, range from as favorable as you would find in any upper-middle-class family to chaotic and disruptive in every respect. When environments are drastically different, the importance of genes fades. To see this, think of a child with great genetic potential for having a high IQ. If the environment is extremely poor, the child will never attain that potential. Another child, with lower genetic potential but growing up in a superb environment, will have a higher IQ. An important implication of the fact that heritability of IQ is very low for lower-SES individuals is that many children in poverty do not get to develop their full genetic potential. That means there is plenty of room for interventions to have large effects on IQ.

New Knowledge about the Effects of the Environment

Much more is known about the effects of environmental factors on intelligence now than was the case when *The Bell Curve* was published, especially regarding the interplay of biological and social factors, thus blurring the line between biological and environmental effects on intelligence.

Biological Factors

A wide range of environmental factors of a biological nature influence intelligence. Most of the known factors are detrimental, having to do with poor nutrition and toxins of various kinds ranging from lead poisoning to alcohol consumed during pregnancy. Most of these detrimental factors are more prevalent among black children than white children, and among children from lower-SES families than children from higher-SES families.†

One biological factor may actually increase intelligence: being breastfed throughout infancy. Breastfeeding may increase IQ by as much as 6 points for infants born with normal weight[16] and by as much as 8 points for those born prematurely,[17] and the advantage seems to persist into adulthood.[18]

Human breast milk contains fatty acids that are not found in formula and that have been shown to prevent neurological deficits in mice.[19] An important study has shown that the 6-point gain with breastfeeding occurs only in people who have a specific form of a gene that regulates fatty acids and is influenced by breast milk—but a large portion of the population has it.[20]

Social Factors

We can be confident that the environmental differences that are associated with social class have a large effect on IQ. The most convincing evidence for this comes from studies of adopted children. Adoption typically moves children from lower- to higher-SES homes; and there are marked differences, beginning in infancy, between the environments of higher-SES families and those of lower-SES families in factors that plausibly influence intellectual growth. The impact on IQ is dramatic: adopted children typically score 12 or more points higher than comparison children (e.g., siblings left with birth parents or children adopted by lower-SES parents).[21] That's roughly equivalent to moving from the 50th percentile in IQ to the 79th percentile.

One of the more important findings about social factors that influence cognitive skills concerns talking to children. An intensive study in which researchers observed 42 families for 2.5 years has shown that, on average, children of professional parents heard 30 million words by the age of 3, whereas children of working-class parents heard 20 million words, and children of unemployed African American mothers heard 10 million words. Increasing the disparities, the vocabulary that the higher-SES children heard was much richer than that heard by the lower-SES children.[22] The study also found a large difference in the number of encouraging comments made to children, compared with reprimands. The children of professional parents received six encouragements for every reprimand; the children of working-class parents received two encouragements per reprimand, and the children of unemployed African American mothers received two reprimands per encouragement.‡ An earlier intensive study of two working-class neighborhoods found similar results. White working-class parents held conversations with their young children. The child says something, the parent responds, and the child responds in turn. But black working-class parents were more likely to talk about their young children than engage in conversation with them.[23]

These findings are amplified by studies using the Home Observation for Measurement of the Environment (HOME). HOME researchers assess family environments for the amount of intel-

Many children in poverty do not get to develop their full genetic potential. That means there is plenty of room for interventions to have large effects on IQ.

*The high heritability of cognitive ability, at least for some parts of the population, has led many to believe that finding specific genes that are responsible for normal variation would be easy and fruitful. So far, progress in finding the genetic locus for complex human traits has been extremely limited. Whereas 282 individual genes responsible for specific forms of mental retardation have been identified,[13] very little progress has been made finding the genes that contribute to normal variation.[14] A recent large study found only six genetic markers associated with cognitive ability, and the six markers considered together barely explained 1 percent of the variation in general cognitive ability.[15]

†To learn more, see "Equalizing Opportunity," by Richard Rothstein, in the Summer 2009 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/summer2009/equalizingopportunity.pdf.

‡To read more about this study, see "The Early Catastrophe," by Betty Hart and Todd R. Risley, in the Spring 2003 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/spring2003/TheEarlyCatastrophe.pdf.

lectual stimulation, as indicated by how much the parent talks to the child; how much access there is to books, magazines, newspapers, and computers; how much the parent reads to the child; how many learning experiences outside the home (trips to museums, visits to friends) there are; the degree of warmth versus punitiveness of parents' behavior toward the child; and so on.[24] These studies find marked differences between the social classes, and they find that the association between HOME scores and IQ scores is very substantial. A HOME score at the 84th percentile compared with the 50th percentile translates into a 9-point difference in IQ (which is roughly equivalent to IQ moving from the 50th percentile to the

73rd percentile). A 9-point difference in IQ characterizes, for example, the average difference between people with some college and people whose education stopped at high school or earlier.

It should be acknowledged that at present there is no way of knowing how much of the IQ advantage for children with excellent environments is due to the environments per se, and how much is due to the genes that parents creating those environments pass along to their children. It is almost surely the case, however, that a substantial fraction of the IQ advantage is due to the environments independent of the genes associated with them. This is because, as I noted earlier, we know that adoption into a higher-SES home adds around 12 points to the IQ of children born to lower-SES mothers.

Home environments are not the only possible factors to explain how environment affects IQ. Home environments are correlated with neighborhood, peer, and school environments. These likely are also important factors that are reflected in the adoption outcomes.

Group Differences in IQ

Two types of group differences in IQ have been exhaustively explored. These are the differences between males and females, and the differences between blacks and whites. Differences between Asians and Westerners have been less well explored, but a brief summary is provided. Little is known about Hispanic American[§] and American Indian IQs, other than that they are lower than those of white Americans and slightly higher than those of blacks, so those group differences are not explored here.

Sex Differences in Intelligence

The subtests of IQ tests are weighted so that males and females come out to the same average of 100 on the overall test score. But in fact, on the great majority of subtests, there really is little or no difference between males and females.[25]

Subtests that show a nontrivial difference between males and females include an advantage for females for verbal abilities such as fluency and memory for words. In almost all countries, females have been found to read more fluently and with greater understanding.[26] There are also large advantages favoring girls in writing ability. This difference is so marked that, on average, eighth-grade girls write at a level characteristic of eleventh-grade boys,[27] a difference that is reduced but not obliterated later in development.

There are very large sex differences favoring males in mental rotation, which is the ability to imagine what an object would look like if it were rotated.** Differences in this ability can be found as young as 3 months of age.[28] Such an early difference strongly indicates that sex difference in this ability has a biological basis. But there is also good evidence for the role of social learning. After being trained with computer games that required use of spatial visualization, there were relatively small differences in female and male college students' performance.[29]

Boys and girls don't differ much on tests of math achievement that measure what is typically taught in school.[30] On average, males have scored about 33 points higher than girls on the SATs over the last 25 years,[31] but that value can be misleading because many more females than males take the SATs.[32] (The higher the fraction of a group that takes a college-entrance test, the lower the expected average for the group because more people who are not highly talented are presumably taking the test.) With samples of highly gifted adolescents, three times as many boys as girls score 700 or more on the mathematics portion of the SATs.[33] This difference can't be explained by boys taking more math courses than girls, so there may be some biological basis to the finding that most students who score at the top in mathematics are male.

There are a number of potential causes of sex differences in various abilities. Overall, female and male brains are similar in organization and structure, but closer inspection shows that most areas have some sex-based differences.[34] On average, the male brain is between 8 and 14 percent larger than the female brain, a difference that is comparable to the sex difference in the mass of other organs, like the heart[35] and kidneys.[36] But overall brain size probably does not account for differences in aspects of intelligence, because all areas of the brain are not equally important for cognitive functioning. In general, females have more gray matter and males have more white matter.[37] Moreover, different patterns of gray and white matter correlate with intelligence for males and females.[38] Some researchers have concluded that the very different brain designs of men and women somehow produce very similar intellectual performance.[39]

§Estimates of the Hispanic-white gap run from two-thirds the size of the black-white gap for IQ tests to only slightly less than the black-white gap for academic achievement as measured by the National Assessment of Educational Progress.

**To learn more about mental rotation and spatial abilities, read "Seeing Relationships," by Nora S. Newcombe, which begins on page 26 of this issue.

Steroidal hormones also play a role in intellectual ability. Prenatal hormones are critical to normal brain development, and both prenatal and postnatal hormones influence behavior, including cognition, in characteristically male versus female directions. It should be stressed that we are far from understanding the intricate interplay of hormones, brain structures, and intelligence.

Some public school districts have begun to segregate girls and boys based on the belief that they are so different intellectually that they need to be educated separately, a belief that stems from faulty extrapolations from research on sex differences in intelligence.[40] An extensive review conducted by the US Department of Education[41] found that the majority of studies comparing single-sex with coeducational schooling report either no difference or mixed results, and other reviews report a host of negative consequences associated with single-sex education, including increased sex-role stereotyping, which may harm both boys and girls.[42] The data from the research literature on intelligence and cognitive skills do not indicate that different learning environments for females and males are a good idea.

As with all group differences, average results say nothing about individual potential. The class poet may be a boy, and the calculus whiz may be a girl.

Black-White Differences in IQ

The Bell Curve encouraged the assumption that a significant portion of the 15-point IQ difference between blacks and whites that existed in the early 1990s might be due to genetics. The authors' treatment of the evidence on this question was biased in the extreme, devoting a great deal of space to the single study that gave significant support to the genetic interpretation, and devoting little space to the considerable amount of direct evidence indicating that the IQ difference is not due to genetics. This evidence stems from the fact that the "black" gene pool in the United States contains a large amount of European genes.[43] Almost all the research indicates no higher IQs for blacks with a significant degree of European heritage than for those with a lesser degree. One of the most telling studies is an adoption study examining the IQs of black and mixed-race children who were adopted early in infancy by middle-class black or white families.[44] When they were studied at age 8, the children who were of half-European origin had virtually the same average IQ as the children who were of exclusively black origin. Hence, European genes were of no advantage. But environment made a big difference. Children (both black and mixed-race) adopted by white families had IQs 13 points higher on average than those adopted by black families, indicating that there were marked differences in the environments of black and white families relevant to socialization for IQ—differences large enough to account for virtually the entire black-white gap in IQ at the time of the study. Tellingly, although Herrnstein and Murray were aware of the existence of this study (which we know because it appears in *The Bell Curve*'s references), they did not discuss the study at all.

The "evidence" by supporters of the genetic view that has received the most attention is the claim that, because brain size is related to IQ for both whites and blacks, and since blacks have smaller brains than whites, lower IQ for blacks is substantially genetic and mediated by brain size. But a within-group correlation does not establish that between-group differences have the same origin. Brain size differences between men and women are much greater than the race differences, yet men and women have the same average IQ. Brain size of full-term black and white infants is the same at birth,[45] and several postnatal factors known to reduce brain size are more common for blacks than for whites.[46] Such factors include chronic stress, which results in both smaller brain size[47] and suppressed generation of new nerve cells in various parts of the brain.[48] Finally, sheer brain size is a rather blunt measure of brain differences, which may be less predictive of IQ than measures of the size of particular regions or measures such as the ratio of gray matter to white matter.

The black middle class has grown substantially in recent decades. Since socialization for cognitive skills differs by socioeconomic status, we could reasonably expect that IQ differences between blacks and whites have gotten smaller. And indeed they

have. The best estimates we have indicate that blacks narrowed their IQ gap with whites by 5.5 points between 1972 and 2002.[49] Changes in academic performance, as measured by the National Assessment of Educational Progress, show comparable gains from the early 1970s to 2008 (averaging over reading and mathematics and over 9-, 13-, and 17-year-olds).[50] Analyzing a wide variety of tests of academic achievement, one researcher found that 50 years ago, the black-white gap was more than 1.5 times (in standard deviation terms) the SES gap.[51] Today, the SES gap is nearly twice as large as the black-white gap.

Stereotype Threat

Our understanding of group differences in intellectual ability is furthered by the very large literature on psychological reactions to negative stereotypes. In an influential 1995 article, Claude Steele, now with Stanford University, and Joshua Aronson, now with New York University, argued that when aware of widespread stereotypes that impugn a group's intelligence (e.g., "Black people are stupid," "Girls can't do math," etc.), test takers frequently experience the threat of devaluation—by themselves, by others, or by both.[52] The resulting arousal and anxiety can impair executive functioning on complex tasks such as standardized aptitude tests. Steele and Aronson called this response "stereotype threat," and demonstrated in a series of experiments that black test takers scored considerably better—sometimes far better—on intellectual tests when the test was presented in a manner that downplayed ability evaluation or downplayed the relevance of race. Since 1995, some 200 replications of the effect have been published, extending the findings to women and mathematics abilities, Latinos and verbal abilities, elderly individuals and short-term memory abilities, low-income students and verbal abilities, and a number of nonacademic domains as well.[53]

A recent review of stereotype-threat research indicated that women's math performance and black students' verbal performance are suppressed, on average, by an amount equal to the difference between the 50th percentile and the 60th percentile.

The stereotype-threat concept has led to a variety of simple educational interventions conducted in schools and colleges that have substantially raised the overall academic achievement of black students[54] and the mathematics achievement of girls.[55] Some of the interventions seem remarkably minor on the surface yet produce substantial gains in academic achievement. For example, simple efforts at persuading minority students that their intelligence is, to a substantial extent, under their control have nontrivial effects on academic performance.[56] A series of classroom exercises over several hours helping junior high students assess what they need to do to achieve their life goals resulted in significant improvement in GPA and reduction in the likelihood of subsequent dropout.[57]

Simple efforts at persuading minority students that their intelligence is, to a substantial extent, under their control have nontrivial effects on academic performance.

Asian-White Differences in IQ

The academic achievements and high occupational profiles of many Chinese and Japanese Americans have inspired speculation about genetic superiority of Asians.[58] James Flynn (the researcher behind the Flynn effect discussed earlier) analyzed schooling and career data for the high school graduating class of 1966. That large sample, which is nationally representative, included a substantial number of Asian Americans.[59] The Asian Americans had about the same average IQ as white Americans (actually, slightly lower) but scored 33 points higher on the SAT than white Americans. SAT scores may reflect motivational differences, such as taking more and higher-level math courses, to a greater degree than do IQ tests. The Asian Americans also exceeded the white Americans in career achievement in later life. Remarkably, Chinese Americans in the class of 1966 ultimately attained occupations of a professional, managerial, or technical nature at a rate 62 percent higher than white Americans. The picture that results is that Asian Americans capitalize on a given level of intellectual ability much better than do European Americans.

Another important study also indicates that Asian achievement has less to do with IQ than with cultural factors. This longitudinal study[60] found that children in Taiwan and Japan had IQ scores slightly lower than those of American children at the beginning of first grade. By the end of the fifth grade, the IQ difference had disappeared, but the math skills of the Asian children were light years ahead of the American children. On a scale where the Americans scored at the 50th percentile, the Taiwanese scored at the 84th percentile and the Japanese scored at the 91st percentile.

There is reason to believe that math teaching in Taiwan, Japan, and some other parts of Asia is superior to math teaching in the United States, but some of the achievement differences are almost surely due to cultural factors. East Asians are members of cultures having a Confucian background. A characteristic belief in those cultures is that intelligence is primarily a matter of hard work.[61] Confucian families exert far more influence on their children than do most families of European culture.[62] They can demand of their children excellence in education and preparation for high-status careers and expect their children to try to comply.

The case for the modifiability of intelligence could scarcely be clearer. People's intelligence is greatly affected by prenatal and immediate postnatal factors; by home environments; by education, including early childhood education; and by changes in the larger culture. How smart we and our children are as individuals, and how smart we are as a society, is under our control to a marked degree.

Interventions

A huge range of interventions have substantial effects on IQ and academic achievement. Of greatest importance to educators, there is clear evidence that school affects intelligence, that better schools produce better effects, and that the caliber of the individual teacher is of great importance.

Education and Other Environmental Interventions

School has a massive effect on IQ.[63] Tragic circumstances in which children are deprived of school for an extended period of time show deficits in IQ equivalent to dropping from the 50th percentile to the 2nd percentile.

Children actually lose IQ points and academic skills over the summer.[64] But this seasonal change in intellectual skills, as we might expect given the different home environments of children of different social classes, is much greater for lower-SES children. Indeed, the knowledge and skills of children in the upper fifth in family SES actually increase over the summer,[65] an effect that is likely due to higher-SES children experiencing intellectually enriched activities during the summer. This effect is so marked that by late elementary school it may be the primary cause of the achievement gap between lower- and higher-SES children.[66]

So schools make a difference to intelligence. And some schools—and some teachers—make more of a difference than others.

The best prekindergarten programs for lower-SES children

Self-Regulation and Schooling

What is it about school and preschool that enhances intelligence and academic abilities? Content knowledge (e.g., learning about climate in different places in the world) and procedural knowledge (e.g., sorting shapes) are of course important, but increasingly scientists are recognizing the importance of developing self-regulatory skills and other noncognitive traits as requisite for high-level intellectual functioning.[1] Self-regulatory skills include behaviors such as being able to wait in line, inhibiting the desire to call out in class, and persevering at a task that may be boring or difficult. There are many terms in the research literature for the general idea that people can recognize, alter, and maintain changes in their behaviors and moods in ways that advance cognitive performance. These terms include self-discipline,[2] the ability to delay gratification,[3] and self-regulated learning.[4]

A classic study of self-regulation found that 4-year-old children who delayed the immediate gratification of eating one marshmallow so that they would be allowed to eat two marshmallows later scored higher on the SAT they took for college entrance more than a decade later.[5] A study with similar implications was conducted with eighth-grade students at a magnet public school.[6] Students were given envelopes that contained $1. They could either spend the dollar or exchange the envelope for one containing $2 the following week. In addition, students were rated on numerous other measures of self-discipline. The authors reported that scores on a composite measure of self-discipline predicted academic performance and learning gains over the academic year in which the study was conducted and did so better than IQ tests. Similar studies with college students at Ivy League schools, students at a military academy, and spelling bee participants found that self-discipline and ability to delay gratification predicted success across a variety of academic measures.[7]

There is evidence that self-control, or at any rate some set of noncognitive motivational factors, contributes not only to life outcomes but to IQ scores themselves. A team of researchers has shown in a meta-analysis of more than 40 samples that incentives for good test performance improve IQ scores by about 10 points.[8] For samples for which the average baseline IQ was less than 100, the gain due to incentives was about 14 points. The lower the baseline IQ, the greater the gain due to incentives, and the larger the incentives offered, the larger the IQ gain. The investigators also examined the correlates of assessed test-taking motivation (based on refusal to attempt parts of the test, responding rapidly with "I don't know" answers, etc.) for a group of middle school boys. IQ predicted academic outcomes in adolescence and total years of education by the age of 24. So did the nonintellective traits, though to a lesser degree. Nonintellective traits predicted nonacademic outcomes—criminal convictions and employment in adulthood—as well as IQ did.

–R.E.N.

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have a substantial effect on IQ, but this typically fades by late elementary school, perhaps because children's environments do not remain enriched. However, there are two studies that provide exceptions to the rule that prekindergarten programs have little effect on later IQ. In both, children moved into average or above-average elementary schools following the prekindergarten interventions. On average, children in one of the programs[67] had IQs 10 points higher than those of controls when they were adolescents. Children in the other program had IQs 4.5 points higher than those of controls when they were 21 years old.[68]

Whether or not high-quality preschool programs have sustained IQ effects, their effects on academic achievement and life outcomes of lower-SES children can be very substantial. The gains are particularly marked for intensive programs with parent-education components, such as the HighScope Perry Preschool Program[69] and the Abecedarian Project.[70] By adulthood, individuals who had participated in such programs were about half as likely as individuals in a control group to have repeated a grade in school or to have been assigned to special education classes, and they were about a third more likely to have completed high school, to have attended college, and even to own their own home. The discrepancy between school achievement effects and IQ effects is sufficiently great as to suggest that the achievement effects are produced more by social and emotional changes such as greater self-control and perseverance than by intellectual gains per se.[71] (For more on these factors, see the sidebar above.)

Whatever the route to educational and life outcomes, there is no question that high-quality early childhood education pays off. Economists have estimated return on the dollar for these programs to be on the order of 4-to-1 up to 8-to-1.*

Quality of teaching in kindergarten also has a measurable impact on academic success and life outcomes. One group of researchers[72] examined data from a significant study, Project STAR, in Tennessee. They found that students who had been randomly assigned to small kindergarten classes were more likely to subsequently attend college, attend a higher-ranked college, and have better life outcomes in a number of respects. Students who had more-experienced teachers had higher earnings as adults, as did students for whom the quality of teaching, as measured by test scores, was higher. Academic gains due to having more-experienced, superior teachers faded in later grades, but noncognitive gains persisted, much as for the pre-elementary interventions just discussed. In fact, having a kindergarten teacher at the 60th percentile of educational effectiveness rather than the 50th percentile was found to be worth $1,000 per year in income. Multiplied by the 20 or so children in the average class and the 30 or so years of a teacher's career, the benefit of a superior kindergarten teacher adds up to hundreds of thousands of dollars in economic gain for society as a whole.

Similarly, first-grade teaching quality has a significant impact on academic achievement in later grades. For instance, one study[73] found that children who were at risk for poor elementary school performance by virtue of relatively low SES had achievement scores equivalent to 15 percentile points higher if their first-grade teacher was one whose teaching quality was considered by researchers observing the classes to be in the top third as opposed to the bottom third. Indeed, the performance of the children with the better teachers was not significantly worse than that of children with well-educated parents. So, how did these better teachers differ from the others? In three-hour observations of each class, teachers were rated for their instructional and emotional support. According to the researchers, "high-quality instructional support in this study was observed when teachers made frequent and effective use of literacy instruction, evaluative feedback, instructional conversations, and encouragement of child responsibility."[74] And in classrooms they rated high in emotional support, "teachers were aware of and responsive to individual students' needs, offered effective and proactive behavior management, and created a positive classroom climate in which teachers and students enjoyed each other and their time in the classroom."[75] Quality of emotional support contributed to children's achievement independent of quality of instructional support.

Researchers with the Consortium on Chicago School Research have also found instructional and emotional support to be critical to effective teaching. In a study of sixth- through eighth-grade students, they found that the combination of academic pressure (which included rigorous content and high expectations for student performance) and social support (from teachers, peers, and parents) had a very strong impact on achievement. In reading, students in classrooms that were high in pressure and support gained almost two grade-level equivalents; in math, they gained more than two grade-level equivalents.[76]

Helping all children reach their full IQ potential will require a wide range of health care, social services, economic, family, neighborhood, and school interventions.

Of course, this does not mean that teachers alone should be expected to close the IQ and achievement gaps. There is a significant body of research on how to foster high-quality teaching. That research is beyond the scope of this article, but it includes quality leadership, rigorous curriculum, collaborative school environment, ongoing professional development, parent and community partnerships, and more.† In addition, many interventions in elementary school that do not directly address the quality of teaching, including lengthened school day, decreased class size, and interactive computer programs, have been found to markedly affect academic skills.[77]

For policymakers, the evidence on the importance of schooling and the evidence on the importance of socioeconomic status and the home environment are equally important. IQ and achievement gaps begin not just at home, but in the womb. Helping all children reach their full IQ potential will require a wide range of health care, social services, economic, family, neighborhood, and school interventions.‡ ☐

(Endnotes on page 38)

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*To learn more, see "The Economics of Inequality," by James J. Heckman, in the Spring 2011 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/spring2011/Heckman.pdf.

†See, for example, "Teacher Performance in the Context of Truly Disadvantaged Schools in Chicago," by Elaine Allensworth, in the Fall 2011 issue of *Voices in Urban Education*, available at www.annenberginstitute.org/VUE/wp-content/pdf/VUE31_Allensworth.pdf. Also see "Learning to Teach Nothing in Particular," by David K. Cohen, in the Winter 2010–2011 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/winter1011/Cohen.pdf.

‡See, for example, the complete Spring 2011 issue of *American Educator*, available at www.aft.org/newspubs/periodicals/ae/spring2011/index.cfm (see especially "Greater Equality: The Hidden Key to Better Health and Higher Scores," by Richard Wilkinson and Kate Pickett: www.aft.org/pdfs/americaneducator/spring2011/Wilkinson.pdf).

School Ties

A Psychiatrist's Longtime Commitment to Education

ILLUSTRATIONS BY PAUL ZWOLAK

By Jennifer Dubin

Almost 60 years have passed since Dr. James Comer last saw three of his elementary school friends, yet he vividly remembers them. They were African American boys just like him. They, too, came from two-parent homes, and their fathers also worked in the local steel mill. But unlike Comer and his siblings, these three youngsters did not take an interest in academics. They grew up to lead hard lives: one died from alcoholism, a second was in and out of jail, and a third was in and out of mental institutions. As a young man, the question that always haunted Comer was why.

His mother had an idea. "Madison was known as a troublemaker in school, and yet he was a bright boy," she once told her son about one of these friends. "His problems stemmed from his family life. I don't think they sat and talked with the children or did anything together."[1]

Comer's own childhood differed considerably. His parents routinely sat and talked with him and his siblings; the family did everything together. Ultimately, the stark, sad contrast between his experiences at home and those of his friends led him to devote his life to studying the science behind his mother's keen observation.

To understand how promising lives sometimes falter and fail, Comer decided to learn about people. And so he trained in psychiatry at Yale University in New Haven, Connecticut. His work in the early 1960s at the university's Child Study Center taught him that many adult problems are actually rooted in childhood. With time, he began to understand the decline of his three friends.

In 1968, Comer and his colleagues at the center created the School Development Program.* The program focuses on improving relationships among the adults in schools—teachers, administrators, other staff members, and parents—so they can foster academic achievement and support student development. The model, mainly geared toward elementary schools, is based on Comer's belief, grounded in research, that academic learning and

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Jennifer Dubin is the assistant editor of American Educator. *Previously, she was a journalist with the* Chronicle of Higher Education. *To read more of her work, visit* American Educator*'s authors index at www.aft.org/newspubs/periodicals/ae/author.cfm.*

*To learn more about the School Development Program at Yale University, visit www.schooldevelopmentprogram.org.

child development are inextricably linked and proceed along six specific pathways: social-interactive, psycho-emotional, ethical, cognitive, linguistic, and physical.

According to Comer, a medical professor and child psychiatrist at Yale, healthy development in school occurs when children form positive relationships with adults. First, though, adults must create school climates in which they relate well to each other. When they do, they become emotionally available to bond with students and to model positive behaviors. It is their relationships with adults, combined with a strong academic curriculum, that in turn motivate children to learn.

Often, children from low-income families do not receive the nurturing inherent in positive family relationships. Economic hardships and stress that cause parents to work multiple low-wage jobs may not allow them the time to engage their children the way middle-class parents typically do—and some may not even know how to engage them.† And so Comer regards schools as the only institutions strategically located to work with parents and communities to foster the healthy relationships poor children desperately need.

When he began his work, few shared this view. Long before *A Nation at Risk* warned in 1983 that "a rising tide of mediocrity" threatened our schools, urging that we make them a national priority, and long before society understood the achievement gap's far-reaching consequences, Comer realized the tremendous power of schools to change the course of a child's life. He has spent his career helping educators harness that power. He argued and still argues that schools can build character, encourage persistence, teach self-regulation, and shape students into citizens able to contribute to democracy. The best education prepares children academically *and* for life.

For more than 40 years, Comer and his team at Yale have worked with more than a thousand schools to implement a framework that enables schools to support all students, especially those from low-income families. Over the years, evaluations have found the model to be effective; in many schools, the program resulted in significant improvements in student behavior, parent participation, and academic achievement. But in recent years, its good work has largely been ignored.

As the emphasis in American education has increasingly focused on standardized test scores, this program focused on relationships has fallen out of favor. And though he wishes it weren't so, Comer knows that fads—not sound research—often dictate education policy.

At 78, Comer still works full time and does not plan to retire. Though he no longer oversees day-to-day operations of the School Development Program or teaches, he continues to write commentaries and to speak at conferences and schools. He is the author of 10 books and hundreds of articles that explain how children develop. For 15 years, he shared his expertise with the public as a columnist for *Parents* magazine. In his writings, he often shares personal stories about his family and its pride in him for becoming a physician and the first African American to earn tenure at Yale.

Even though Comer has received nearly 50 honorary degrees, many educators today may not have heard of him. Unlike some other school improvement advocates, he is more of a scholar than a salesman. An intellectual, he has long relied on reason to make his case in a field where passions and good intentions often reign supreme. "I received standing ovations in the beginning of my career," Comer says, explaining that he once gave fiery orations about his work. "I toned down my presentations because I watched the same people stand up and cheer me and then do things that don't serve children well. I try to get at the head, not the heart."[2]

His ideas, though, strike at the heart of what a good education is all about, and how classroom teachers, especially those of low-income students, can provide it. For the question about his friends that first intrigued him long ago bears a strong resemblance to the one that educators often ask themselves about their students: How can I best help them reach their potential? It's what all great teachers want to know. A look at Comer and his life's work provides valuable insights into the ways that educators and schools can connect with children.

> The School Development Program focuses on improving relationships among the adults in schools so they can foster academic achievement and support student development.

An Interest in Child Development

Comer's parents, a steel mill worker and a cleaning lady, taught him, his two brothers, and his two sisters to value education and the opportunities it can create.

Originally from the South, Hugh and Maggie Comer started their family in East Chicago, Indiana. Even with limited funds, they exposed their children to educational enrichment. They visited museums, attended plays, and took sightseeing trips to nearby Chicago, Illinois. They ate dinner together as a family and encouraged debate on the events of the day.

Comer and his siblings learned much at home, and they thrived academically. They attended a racially integrated, predominately white school that enrolled many middle-class and affluent students.‡ Comer believes that the mostly positive interactions with classmates and teachers, and the strength of the academic program, combined with his parents' support, are what led him and his siblings to earn a total of 13 degrees and to become

†For more on how poverty affects learning, see: "Why Does Family Wealth Affect Learning?," by Daniel T. Willingham, in the Spring 2012 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/spring2012/Willingham.pdf; the complete Spring 2011 issue of *American Educator*, available at www.aft.org/newspubs/periodicals/ae/spring2011/index.cfm; and "Equalizing Opportunity," by Richard Rothstein, in the Summer 2009 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/summer2009/equalizingopportunity.pdf.

‡For more on the benefits of integrating schools by socioeconomic status, see "From All Walks of Life," by Richard D. Kahlenberg, in the Winter 2012–2013 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/winter1213/Kahlenberg.pdf.

professionals: an optometrist, a principal, a school district superintendent who became a community college dean, and a French teacher who headed the local Head Start.

Not long after Comer finished his medical training, he realized he wanted to work with low-income children to ensure their lives turned out better than those of his three elementary school friends. When the director of the Child Study Center at Yale asked him to head a school improvement program, he jumped at the chance.

It was September 1968, nearly five months after the assassination of Martin Luther King Jr., amid a time of great upheaval, when Comer, along with a social worker, a psychologist, and a special education teacher from the center, walked into two struggling elementary schools to learn and to help. Nearly all of the students were African American and poor. Out of New Haven's 33 schools,

these two had the worst achievement scores and attendance rates. Discipline problems were rampant, and staff turnover was 25 percent each year.

Initially, teachers, administrators, and parents resisted; they did not trust the well-meaning team. Though the schools were just a 10-minute walk from the campus of the prestigious university, they represented a different world. Comer persuaded the adults in both schools to work with him, and the School Development Program slowly evolved.

The model they eventually created, with input from teachers, administrators, and parents, involves organizing the adults in the school, along with several parents, into three teams—the School Planning and Management Team, the Student and Staff Support Team, and the Parent Team—that work together to create a Comprehensive School Plan. The plan is based on decisions that the teams make on a range of issues, including curriculum, instruction, and assessment. The teams also set goals for the overall school climate and ensure that staff members communicate with the community.

These teams provide adults with a framework in which to promote children's social-interactive, psycho-emotional, ethical, cognitive, linguistic, and physical development.[3] According to Comer, children who are healthy are not only physically well. They can make friends and show empathy for others. They are self-aware and can express themselves. They can acquire academic knowledge and also apply what they learn.

In 1968, the prevailing notion was that schools could not help low-income students because their families and communities could not provide them with the social capital (mainstream knowledge and skills) needed to succeed in school. At the time, many argued that only school integration could overcome such a challenge. Largely because of his own supportive family and his understanding of child development, Comer declined an opportunity to focus on racial integration and instead focused on helping to create vital school cultures in low-income schools so that students could reach their potential. Because the School Development Program focuses on healthy child development, low-income students exposed to it gain the mainstream knowledge and skills that their middle-class peers often learn at home.

While this model recognizes that the principal is ultimately in charge of the school, the framework helps to prevent top-down decision making and encourage teamwork. To that end, three principles guide the teams: consensus decision making, in which teams reach a consensus rather than vote on issues (which can create "winners" and "losers"); no-fault problem solving, which allows teams to focus on finding solutions instead of blaming others; and collaboration, which encourages the principal to partner with the teams and respond to their concerns, while team members continue to respect the principal's authority.

"People who don't know each other, who don't trust each other, who don't like each other, can't work together," Comer says.[4] In such an environment, chaos ensues. Once the program brings key people together and they begin to experience a little success, then "those people who didn't know each other, who didn't like each other, who didn't trust each other, begin to know, trust, and like each other."[5]

Adults then experience improved interactions with children who "are then interacting in a supportive environment that motivates them to learn," he says.[6] With sound relationships, staff members and parents can focus on preparing students academically and on helping them to develop socially. What Comer first learned in New Haven is that when compared with mental health professionals, educators typically don't understand what a child's classroom behavior, good or bad, really means.

Soon after his team began its work, an 8-year-old boy from a small community in North Carolina enrolled in one of the schools. He had recently moved to New Haven to live with his aunt, who dropped him off at school one morning. Comer writes that when the student walked into his new classroom, the teacher's "facial and body language expressed frustration and, to the student, rejection."[7] As a result, the child panicked, kicked the teacher in the leg, and ran from the room. Comer did not blame the teacher; she already had three transfer students in her class from the previous week. Rather than give the student a lecture, the teacher and principal worked with Comer and his team to understand the cause of the child's behavior: he was in a strange place with no support. After the incident, the principal and teacher welcomed him by telling him about the school. They also assigned a successful classmate to show him around the building. From then on, new students received similar orientations.

"The students themselves became the carriers of the new school culture," Comer writes.[8] For instance, a couple of years later, when a 9-year-old who had already attended three different schools that year put his fists up to fight after another student inadvertently stepped on his foot, a classmate stopped him. "Hey man we don't do that in this school," he said. Comer writes that the new student dropped his fists. He too "became a carrier of this safe new culture."[9]

Both incidents showed Comer that teachers often lacked the knowledge to understand students' actions and so were placed in a tough position. "We do not prepare them to 'read' child behavior, but we expect them to respond to it in ways that can be helpful," he writes. "We do not do that to other professionals."[10]

Too many teachers, he realized, exit teacher preparation programs and enter the profession without even knowing they can support healthy development. What makes his program unique is that it shows them how.

Soon after the adults in these two schools implemented the model, student behavior and staff morale improved and parent involvement—volunteering to organize events, meeting with teachers to discuss their child's progress—increased. After a few years, educators in the original two New Haven schools began to see significant academic improvements in reading and math.

The program's success in those two schools was not an anomaly. A study published in 2002 of Comprehensive School Reform programs—school improvement models for which some schools received federal funding—found that of the 29 most widely implemented programs, only three were effective. The School Development Program was one of those three.* Comer emphasizes that the purpose of the model is not to raise test scores, although this occurs when implemented well. The point is to show that "when we create conditions that support the development of children," he writes, "they will learn."[11]

Turning Curiosity into Academic Learning

Comer says that we as a nation still have not made creating those conditions a priority. Sitting in his office one October afternoon, he tells me that American education started with the wrong model and has yet to change. "The focus was on just pouring information in, and the belief was that those with the best brains would get it, and the others won't, and that's okay," he says.[12]

But he recognized that it is not okay. Comer explains that people are born with potential that is realized only when they interact with those who support their development and engage them so that their curiosity is turned into academic learning. "I'm a medical doctor," he says. "I always say, of all the babies I delivered, there was not one born with an interest in academic learning."[13]

As Comer is well aware, teachers understand that developing that interest is important, but too often policymakers view it as touchy-feely and soft. Yet he has spent his career promoting the idea that the "hard stuff is the soft stuff," as he puts it.[14] Developing strong relationships requires effort and hard work. But the payoff is profound. Ultimately, it is the relationships between adults and children—combined with a strong academic curriculum—that stoke a child's interest in learning.

Teachers often lack the knowledge to understand students' actions: "We do not prepare them to 'read' child behavior, but we expect them to respond to it in ways that can be helpful," Comer writes.

Creating positive relationships, the basis of the School Development Program, takes time. Comer finds that it usually takes three to five years before schools using it see improvements in student achievement. The approach works best when a critical mass of parents attend meetings and activities in support of the school program so they can learn how to support their child's development and improve their own parenting skills. Educators, too, must invest time in engaging with parents and colleagues. Both teachers and administrators find that a positive school climate enables them to spend less time addressing student behavior problems and more time focusing on instruction.

Comer says that despite the continued interest of parents and educators in those first two New Haven schools, his team pulled out because of a lack of funds. They left in 1980 after 12 years.

The schools, however, continued the program; both sustained their progress for some time. In an article for *Scientific American*, Comer wrote that by 1984, fourth-grade students in the two schools ranked third and fourth in the New Haven school district on the Iowa Test of Basic Skills in reading and math. He also noted that one of the schools had among the best attendance rates in the school district, and that "there have been no serious behavior problems at either school in more than a decade."[15]

In 1980, Comer set about documenting the results his program achieved in those schools with his third book, *School Power: Implications of an Intervention Project*. He recalls that the publish-

*The study also found Success for All and Direct Instruction highly effective. To learn more about those programs, visit www.successforall.org and www.nifdi.org.

ing house bought the book because it was the first to demonstrate that schools can help poor children learn. "But it won't sell," Comer recalls the publisher telling him. "Nobody cares about education."[16] Comer shares this anecdote to give a sense of the climate regarding education at the time. He contends that unlike today, near panic had yet to set in.

A few years after Comer and his colleagues left the original two schools, they field-tested the model in schools in eight different states. The program's strong results in those schools earned them the foundation grants they needed to disseminate the model further. Throughout the 1990s, Comer continued writing about the program. School superintendents and other educators who read his work wanted to learn more about how child development and academic learning were linked, and they wanted their schools to improve. Several districts adopted the model, and Comer received grants from foundations and the US Department of Education to enable his staff to provide support. Newspaper articles at the time highlighted a strong and growing interest in the program. In the 45 years since its inception, the model has operated in more than a thousand schools in the United States and around the world.

When No Child Left Behind (NCLB) became law in 2002, the program's growth ground to a halt. Comer says that the law, focused on test scores, did not include a developmental perspective. As a result, even schools that had successfully implemented the model eventually dropped it and then saw their improvements in student learning and school climate fade. Many stopped the trainings on collaboration to concentrate on test prep instead. According to Comer, the trainings, which took place at Yale, saw a dramatic decline in attendance as the law was being considered and soon after it passed. While 1,988 teachers and administrators attended trainings in 2001 and 1,476 teachers and administrators attended trainings in 2002, only 467 did so in 2003. The decline continued to the point that Comer and his staff discontinued the trainings at Yale and held them within school districts and for fewer participants. Without a continued focus on development, "teachers and administrators will fall back into old ways of doing things," he explains. "The difference is so subtle that it's hard to see."[17]

The high-stakes climate that NCLB created around preparing students to pass standardized tests, along with the touchy-feely label that has unfairly been attached to the School Development Program, has meant that in recent years Comer has struggled to find funding. Today, to implement the model in a single school costs about $30,000 each year. Without grant support, it's a sum that many schools simply can't afford.

In the wake of NCLB, Comer has mainly focused on building partnerships between school districts and colleges of education to help them support student development and academic learning. He also works a great deal on education policy, regularly participating on panels of national education experts.

"Ahead of the Game"

Like his program, Comer, at first glance, seems subtle. He speaks deliberately and earnestly. His voice is not booming, nor is he physically imposing. Yet behind the intellectual reserve lie passions for playing basketball and unwinding on the dance floor that help explain his youthful appearance. To reach his third-floor office, he takes the stairs, never the elevator. The professor prides himself on physical fitness.

For his efforts to improve schools, Comer has garnered considerable acclaim. He has lectured across the country and abroad and is the recipient of many prestigious awards. On a wall in his office, he proudly displays pictures of Bill Cosby and Hillary Clinton speaking at the 25th and 30th anniversary celebrations, respectively, of the School Development Program. In 2007, he received an honor highlighting both his contribution to public education and the fact that some believe he deserves even more recognition. The Grawemeyer Awards, from the University of Louisville in Kentucky, are given in five categories each year, including education. They are named for H. Charles Grawemeyer, an industrialist and entrepreneur, and an alumnus of the institution, who established the prizes. According to the awards' website, Grawemeyer, though he studied chemical engineering, so highly valued the liberal arts that he "distinguished the awards by honoring ideas rather than life-long or publicized personal achievement."

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In his introductory remarks during the award ceremony, David Reynolds, an education professor in the United Kingdom, noted that Comer was ahead of his time. He compared him to Martin Peters, a member of the UK's winning World Cup team in 1966, who was so talented a soccer player that he was considered to be "twenty years before his time." Reynolds said that Peters saw the field in such a way that he knew where to pass the ball, but his teammates couldn't anticipate the plays. "He was just ahead of the game."[18]

Reynolds made the point that the same holds true for Comer. In the decades since he and his colleagues first began their work, American public schools generally have adopted more of the professor's "plays," his line of thinking if not his exact program. "It is as though today's theoretical mountain has moved closer to Comer, making his program less intellectually unique than it was 30 years ago," wrote Thomas Cook in a 1999 evaluation of the School Development Program in Prince George's County, Maryland. Cook cited other programs that also focus on "decentralized governance, parent involvement, better quality staff relationships, more emphasis on child development, setting higher standards, and seeing schools as communities rather than production factories."[19] Comer himself acknowledges that since he first introduced the program, the ideas behind it have become more mainstream. School Development Program "practices considered highly controversial in 1969—whole-school change, school-based management, strong parental involvement in decision making, and teacher study groups—are now common in schools throughout the country," he writes.[20]

Central to Comer's model is the notion that child development and academic learning are inextricably linked, which a body of research now supports. For instance, the Consortium on Chicago School Research at the University of Chicago has examined the supports students need to develop socially and academically. A report that the group published last year found that when teachers help students develop positive attitudes and behaviors that char-

acterize effective learners, they can increase students' chances of success in school and in life.[21]

The consortium also assessed the impact of social support (for example, homework help from teachers and parents, cooperation and respect among peers) and academic pressure (such as teachers setting high standards for students) on achievement. It found that when children experience high levels of both support and pressure, they make significant gains in math and reading.[22] As Charles Payne writes about the consortium's work, "the main message from the study is that social support and academic pressure each independently make a meaningful difference, but when both are present at high levels, the results can be striking."[23]

Based on the consortium's findings, Payne, a professor in the School of Social Service Administration at the University of Chicago, writes that an "authoritative-supportive" teaching model that includes a "high level of intellectual/academic demand," a "high level of social demand," a "holistic concern for children," and a "strong sense of teacher efficacy and legitimacy" could best prepare students academically and develop them socially.[24]

Payne's analysis echoes ideas that James Heckman says have received scant attention. "Important character traits that promote personal achievement are largely ignored or maligned as 'soft' and nonmeasurable skills," writes the economist and Nobel laureate. "Evidence suggests that efforts that focus mainly on closing disparities in cognitive achievement are not as successful as they could be because they neglect the need to close gaps in character development."[25]

Angela Duckworth specifically studies such development. The University of Pennsylvania professor has found the importance of self-control, perseverance, and conscientiousness in predicting student achievement. She explains that "a major reason for adolescents falling short of their intellectual potential is a lack of self-discipline." As a result, "effective interventions geared at helping students exercise self-discipline are of pivotal importance."[26] Ultimately, the work of these scholars reinforces the ideas on which Comer's program is founded.

Instead of focusing on the research supporting development, Comer says that we have given in to "distractions" such as charter schools and vouchers. He labels them as such because it's the core interactions within schools—not their management or organizational structures—that make a difference in student learning.

However, he does admire Geoffrey Canada, founder of the Harlem Children's Zone. Comer says that the School Development Program has informed a lot of Canada's own work and focus on wraparound services. But Comer says that he has had frank discussions with Canada about society's lack of concern for poor children. And while the press has lauded Canada's program, that praise ultimately rings hollow, he says, because society refuses to address child poverty and institutionalize the supports Canada advocates. "I've already told him, 'Look out for being held up as novel,'" he says. "In a few years, they'll be looking for something new, and they'll want to go around what it is he does."[27]

All these years later, Comer still marvels at how much his home life positively influenced his academic success. He explains how the support of family and friends sustained him during one of his toughest years: his freshman year at Indiana University. He says that the racism he experienced at the institution, which then enrolled few African Americans, made him question his ability to succeed. When an English professor first praised a paper Comer had written but then began criticizing it to the class after learning that Comer was black, the experience nearly crushed him.

After talking with people back home who believed in him, he persisted. "In my family, you just kept going," he says.[28] Comer recalls that his mother, who had an abusive stepfather and also experienced racial discrimination, modeled how to face adversity.

Comer contends that if children don't learn that lesson at home, they can learn it at school—that is, if the school provides the right environment, including the right stories. For example, "the Jackie Robinson story *is* the story," he says, but too often, schools miss the point. "They teach that Jackie Robinson was the first African American in baseball. That's not the story. The story was his persistence, self-regulation, determination, cool under fire, demonstration of excellence."[29] All of those character traits, along with academics, he says, are what the school ought to teach.

To that end, Comer says that schools of education, which prepare the majority of the nation's educators, must teach what he has long taught: the centrality of child development to academic achievement. Just as medical schools more than 100 years ago decided to focus on anatomy and physiology—the basic sciences of medicine—and to stop "being overrun by all kinds of people selling everything and claiming everything, and little science," he

(Continued on page 40)

Seeing Relationships

Using Spatial Thinking to Teach Science, Mathematics, and Social Studies

By Nora S. Newcombe

Alchemists, who searched for centuries for a method of making gold from less valuable metals, may seem like scientists. After all, they *experimented*—that is, they combined various substances in various ways to see if they could manufacture gold. Yet alchemists are not commonly called scientists. They experimented rather blindly, without understanding the underlying system of elements and the mechanisms of their chemical combination. During the 18th and 19th centuries, mathematical formulations such as Boyle's law began to change alchemy into the science of chemistry. Still, the major event in systematizing our knowledge of elements and chemical reactions—and thus creating a real science—was the periodic table proposed by Dmitri Mendeleev in 1869. The periodic table is one of the most recognizable spatial structures in all of science. Its famous rows and columns organize the relationships among elements. For scientists, looking at the table allows for predictions, including the possible existence of undiscovered elements. For students, looking at the table may provoke questions that will deepen their understanding—for example, why are two elements alone at the top, at opposite sides of the table?

The use of spatial relationships to make scientific discoveries and to communicate mathematical and scientific insights is not unique to chemistry. Just 15 years before Mendeleev published

Nora S. Newcombe is a professor of psychology at Temple University and the principal investigator of the Spatial Intelligence and Learning Center (which is funded by the National Science Foundation). She has been a visiting professor at the University of Pennsylvania, Princeton University, and the Wissenschaftskolleg in Berlin. She is also a past president of the Developmental Psychology division of the American Psychological Association.

ILLUSTRATIONS BY LAURA MCCABE

his periodic table, a London physician named John Snow was confronting an epidemic of cholera. Many people thought at the time that cholera was caused by "miasma," or bad air, but Snow noted that the cholera cases were clustered—and wouldn't that be odd if the bad air hypothesis were true? Suspicious that the disease was actually caused by bad water, he made a map showing where sick people were living. He also placed marks on the map to indicate the locations of the pumps from which Londoners of the time obtained their water (see Figure 1 below). On this map, the clustering of cholera cases around the pump located on Broad Street was easily visible, which led Snow to conclude that water was more likely the problem than air. Snow has been called the founder of modern epidemiology, but he could just as well be called the founder of social studies. Maps are a potent tool in discovering how things go together in anthropology, geography, economics, sociology, and history.

Tables and maps are not the only powerful spatial learning tools. There are graphs and diagrams, photographs of objects seen through microscopes and telescopes, and sketches and drawings made both as records of observations and "on the fly," as people work to imagine and communicate scientific laws. Let's look at one more example of the power of spatial representations: how a graph can communicate about economics very clearly and in a way that provokes reflection and question-asking. The graph in Figure 2 (below right) of job losses and gains in the American economy over the past decade looks like a roller coaster ride. On closer examination, we see the job losses that occurred in the economic crisis of 2008–2009, and then we see a slow, steady rebound beginning in 2010, with growth at a rate pretty equivalent to growth before the downturn. We also see that this growth is not sufficient to get us back on track relative to where we might have been without the downturn. All of these facts, both the good news and the bad news, are simultaneously evident—at least to a student who knows how to read graphs.

The Role of Spatial Ability

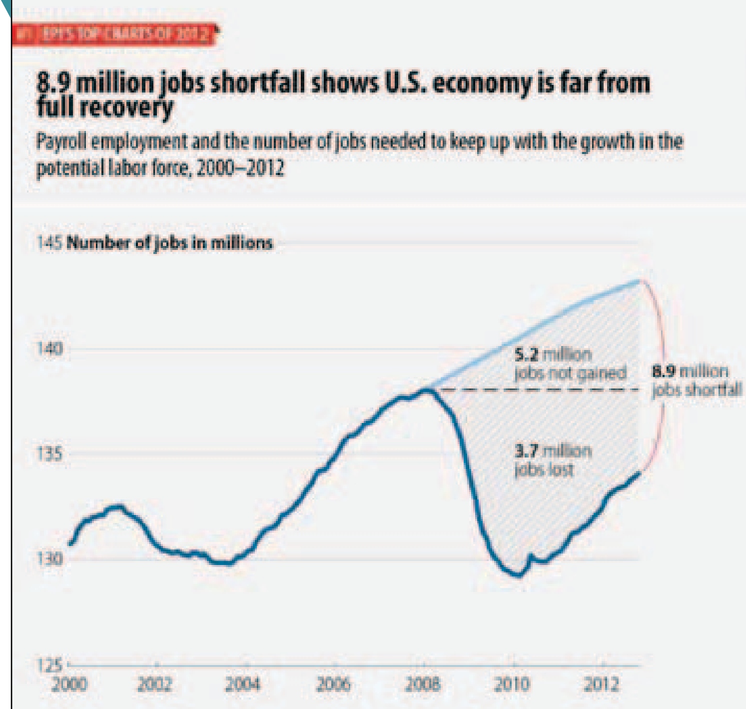
Ideally, learning science, mathematics, and social studies ought to be intensely spatial activities. And in some ways they are. Middle school science textbooks, for example, typically feature about one image per page.[1] Yet many students could use a lot more help in learning how to interpret these visualizations. Some students seem to cope better than others with the spatial demands of learning science and social studies, as well as with the spatial aspects of mathematics (including geometry, trigonometry, and graphing algebraic functions). Research shows that students high in spatial ability learn better from visualizations than students with lower spatial ability.[2] Likely as a consequence of such differences in learning, higher spatial ability predicts

> Teachers can help students strengthen their ability to learn spatially and benefit from studying visualizations such as maps and graphs.

Figure 1

SOURCE: WWW.EN.WIKIPEDIA.ORG/WIKI/FILE:SNOW-CHOLERA-MAP.JPG.

Figure 2



SOURCE: ECONOMIC POLICY INSTITUTE, "CHARTING THE STATE OF THE U.S. ECONOMY: EPI'S TOP CHARTS OF 2012," WWW.EPI.ORG/PUBLICATION/TOP-CHARTS-2012. REPRINTED WITH PERMISSION.

interest and success in the STEM disciplines (science, technology, engineering, and mathematics). Even after accounting for verbal and mathematical ability, high school students with higher spatial scores are more likely to be working in the STEM disciplines during their adult lives.[3] Similarly, preschoolers who perform better on a test of spatial transformations are better at mathematics as 8-year-olds, even after accounting for verbal ability.[4] In addition, professionals in the STEM disciplines, especially the geosciences and geography, report being better able to navigate their environments than people working in other occupations.[5] Navigation, or "wayfinding," is a somewhat different kind of spatial ability than the mental rotation tasks (see box below) typically used to assess spatial ability, but navigation may be as important in STEM learning and social studies learning as mental rotation, likely because of the usefulness of maps.

What do these findings mean for teachers? We'll take a look at that issue in a moment. But to avoid any misunderstanding, let's begin by explicitly stating what the findings do *not* mean. First, they don't mean that verbal explanation is unimportant, or that expressing ideas in mathematical equations is wrong. Verbal, mathematical, and spatial presentations all have both strengths and weaknesses, and classroom practices should include all of these kinds of communication. Second, these findings don't mean that individual students have individual "learning styles,"* and that some students learn better by reading text and listening to lectures, while other students should study diagrams and graphs. In fact, there is currently little scientific evidence for the existence of learning styles.[6] Third, these findings do not mean that students with lower spatial ability should be directed to non-STEM occupations and encouraged to concentrate on humanities or business. Instead, teachers can help such students strengthen their ability to learn spatially and benefit from studying visualizations such as maps and graphs.

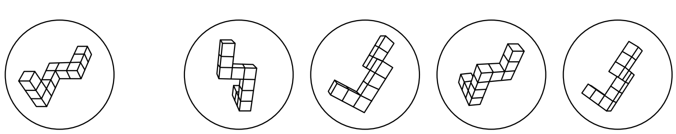
*For a detailed explanation, see "Do Visual, Auditory, and Kinesthetic Learners Need Visual, Auditory, and Kinesthetic Instruction?," by Daniel T. Willingham, in the Summer 2005 issue of *American Educator*, available at www.aft.org/newspubs/periodicals/ae/summer2005/willingham.cfm.

What Is Spatial Ability and How Is It Measured?

Spatial thinking concerns the locations of objects, their shapes, their relations to each other, and the paths they take as they move. Spatial ability is typically measured through tests that ask people to form accurate mental images of spatial relationships and then change them in some way. For example, a very common test item is to ask people to mentally rotate objects like this:

Look at this object:

Two of these four drawings show the same object. Can you find the two?



SOURCE: VANDENBERG, S. G., & KUSE, A. R. MENTAL ROTATIONS, A GROUP TEST OF THREE-DIMENSIONAL SPATIAL VISUALIZATION. *PERCEPTUAL AND MOTOR SKILLS*, 1978, 47, 599–604. © PERCEPTUAL AND MOTOR SKILLS 1978. REPRINTED WITH PERMISSION.

For more examples of how spatial ability can be measured, see the box on page 30 of "Picture This: Increasing Math and Science Learning by Improving Spatial Thinking," an article I wrote for the Summer 2010 issue of *American Educator*. It is available for free at http://bit.ly/bxTc5Q. –N.S.N.

Improving Spatial Ability

It may seem surprising to say that spatial ability can be improved. Intellectual abilities of all kinds are sometimes presumed to be fixed and immutable.† But we have known for decades that, in fact, schooling improves IQ.[7] Spatial ability is no exception to this rule. Together with colleagues at Northwestern University, I recently completed a meta-analysis that examined hundreds of studies of the effects of education and training on different kinds of spatial ability at different ages and for both genders.[8] We found that practicing tasks like mental rotation made performance on tests of this ability faster and more accurate. But simple practice can be boring, so it's important that we also found that relevant academic coursework, such as taking a drafting class, created improvements. So did informal recreational activities such as playing computer games like Tetris, in which falling shapes must be rotated to fit a matrix at the bottom of the screen. Even more important, we found that the spatial improvements created by such activities were durable, lasting at least several months (the longest interval tested in enough studies to be sure of the reliability of the findings). We also found that the improvements generalized, or transferred, at least to somewhat similar spatial tests; for instance, mental rotation training can help you imagine folding a piece of paper into a three-dimensional figure, rather than just helping with mental rotation.[9] Participants of all ages showed improvements too. It didn't seem to be the case that "you can't teach old dogs new tricks."

Are There Sex Differences in Spatial Ability?

What about sex differences? Girls and women usually do not do as well as boys and men on tests of mental rotation, or on some other spatial tests, such as drawing water levels in tilted bottles[10] or constructing cognitive maps from navigation experiences.[11] Does this mean that women are less likely than men to succeed in STEM occupations, perhaps for some immutable biological reason? The answer is no. First, we have to keep in mind that differences between the sexes exist on the average, but that particular women are often better at spatial thinking than particular men. In fact, the distributions of ability for men and for women overlap so much that large numbers of women have better spatial abilities than large numbers of men. Second, we don't really know the causes of these sex differences in spatial ability,[12] and puzzling questions surround them. For example, sex differences are usually not observed in measures of mental imaging of folding two-dimensional paper into three-dimensional structures,[13] even though we know mental folding shares enough cognitive processes with mental rotation that training on one task improves performance on the other.[14] Third, and most important, the meta-analysis my colleagues and I recently completed showed that

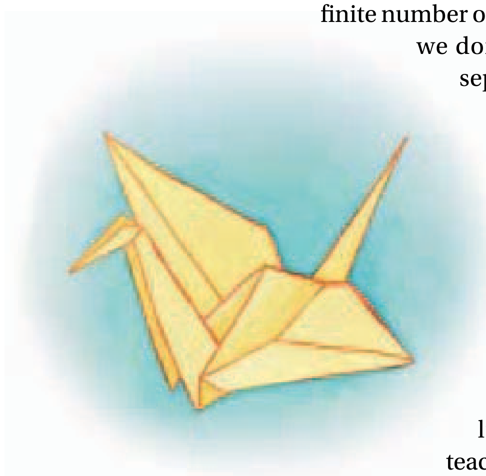
†For a thorough examination of IQ and how to increase it, see "Schooling Makes You Smarter," by Richard E. Nisbett, which begins on page 10 of this issue.

spatial ability is not immutable, and that improvements are very possible. So, there is reason to hope that sex differences could be eliminated through education. Although the meta-analysis indicated that males and females seem to improve in parallel, leaving everyone with better spatial thinking but with males (on average) still excelling,[15] better teaching methods as well as spatial videogames that are more engaging to girls[16] might change this state of affairs in the future.

Practical Consequences

There may be practical consequences to the fact that spatial ability can be improved through education and training. Take the case of engineering. The United States probably could use more engineers,[17] but engineering is a very spatial occupation. If we improved the spatial ability of high school graduates by as much as the meta-analysis tells us we can improve it, then many more people each year would be ready for rigorous training to become engineers. Of course, not everyone who has the requisite spatial ability would be attracted to engineering, and some people might not succeed in it for reasons other than intellectual ability, but the pool of people who might want to at least consider becoming engineers would be increased.

Studies have shown that improvements in spatial ability lead to better grades in chemistry and in physics, as well as to better essays on a problem in geoscience.



Is there direct experimental proof of the hypothesis that interventions that improve spatial ability lead to improved learning of science, mathematics, and social studies? The answer is yes, although many of the studies are new and more work remains to be done. For young children, it seems that training in spatial transformation skills can lead to better performance on arithmetic problems that require spatial representations of what is going on, such as missing addend problems like *3 plus what equals 7*.[18] In fact, the intervention does not need to be explicitly focused on spatial problems, and it can be an enjoyable recreational activity. An afterschool program in which children used arts and crafts materials to make designs (such as an *Ojo de Dios* created by weaving yarn around two sticks, or a pattern constructed using blocks or beads) also led to better math scores in an intervention study with at-risk children.[19] Arts programs have an effect on older students as well. In high school, students taking visual arts gained more in geometry knowledge over the year than students in a theater course or involved in playing squash.[20] For college students, studies with strong methodologies have shown that creating improvements in spatial ability leads to better grades in chemistry[21] and in physics,[22] as well as to better essays on a problem in geoscience.[23]

How Do We Integrate Spatial Learning into Our Crowded Curriculum?

These findings are exciting, but there is an obvious practical problem in acting on the experiments we have considered so far: there is little if any niche in the crowded curriculum to implement most of the interventions discussed, such as extensive practice in solving mental rotation problems or playing videogames. The lack of time is an increasing problem as children advance into middle and high school, where teachers often have too much content in science, mathematics, or social studies to communicate in a very finite number of class periods. Luckily, it turns out that we don't really have to engage students in separate spatial studies. We can "spatialize" the existing curriculum rather than conduct decontextualized spatial training, a strategy recommended in the report *Learning to Think Spatially*, which was published in 2006 by an expert panel convened by the National Research Council of the National Academies.[‡]

Spatializing the curriculum needs to begin with policymakers, curriculum developers, administrators, and teachers knowing more about spatial ability and understanding the need to infuse spatial thinking into the normal school day. As a simple example, the timetable for the day's activities in an elementary school classroom could be set up so that the shorter time periods take up a smaller space and the longer time periods take up a longer space, reinforcing the idea that graphic variation in spacing can have real meaning. There are many other strategies for developing spatial ability and skills in preschool and elementary school, such as doing jigsaw puzzles, promoting guided play with blocks and geometric shapes, and reading books with spatial words in them. Ideas for prekindergarten through grade 4 are presented in some detail in a previous article in *American Educator*.[§] In the remainder of this article, let's take a look at some strategies for middle school and high school.

Strategies for Spatializing Middle and High School Curricula

In this section, we discuss four specific strategies for enhancing and supporting the spatial aspects of the science, mathematics, and social studies curricula. However, these four strategies are examples of what can be done, not an exhaustive list. The overarching concept is to embrace the spatial visualizations used for discovery and communication in these subject areas, helping students learn to read, discuss, and even create these visualizations. Doing so will aid the transmission of content and the future

[‡]To read this report online for free, go to www.bit.ly/Rw6uv.

[§]See "Picture This: Increasing Math and Science Learning by Improving Spatial Thinking," by Nora S. Newcombe, in the Summer 2010 issue of *American Educator*, available at www.aft.org/pdfs/americaneducator/summer2010/Newcombe.pdf.

learning of new content, and the meta-analysis indicates it will probably act as a spatial skills training of its own.

Teach Students How to Read Diagrams

Teachers might assume that their students can read the diagrams that appear on almost every page of science textbooks. In fact, many students often have little idea what the arrows in diagrams may mean, or how the zoom-outs or cutaways relate to the main diagram, and they often fail to read the captions and legends. Some students may rarely consult the diagrams at all, despite the fact that diagrams frequently present information that is not also presented in the verbal text. Consider a typical diagram such as the one shown below in Figure 3. What do the arrows mean, and why are they different colors? What is a cross section (and what is viewed from above)? Where exactly is the water, and where is the land? Identification of "three driving forces" is the goal of the diagram according to the title, but what will the student who fails to read the title learn from the diagram?

Active sketching enhances engagement, deepens understanding, requires reasoning, forces ideas to be made explicit, and supports communication in work groups.

How can this situation be changed? One method is to improve the diagrams. Even students with low spatial ability learn more from improved visualizations.[24] However, teachers do not have time to rethink even half of the diagrams in their students' textbooks, so teachers should try to figure out which handful of diagrams are most critical for each course and focus on improving those. A second strategy is probably even more practical: teachers can take a little bit of time to teach diagram reading explicitly. Along with a team of colleagues, I have developed and evaluated workbooks that take just a few minutes here and there to communicate the importance of captions and legends, and to instruct students on the conventions of diagrams—for example, the various things that arrows can mean, including simple labeling, temporal ordering, causation, and so forth. These exercises, used in a 10th-grade biology class, had positive effects on students' ability to gain information from new diagrams.[25] And in turn, being able to read diagrams has positive effects on learning content. In one study, students learned more about the circulatory system when asked to explain diagrams than when asked to explain text.[26] In fact, diagrams may have positive effects on learning primarily when students actively engage with them in ways that support them in constructing explanations of scientific phenomena.[27]

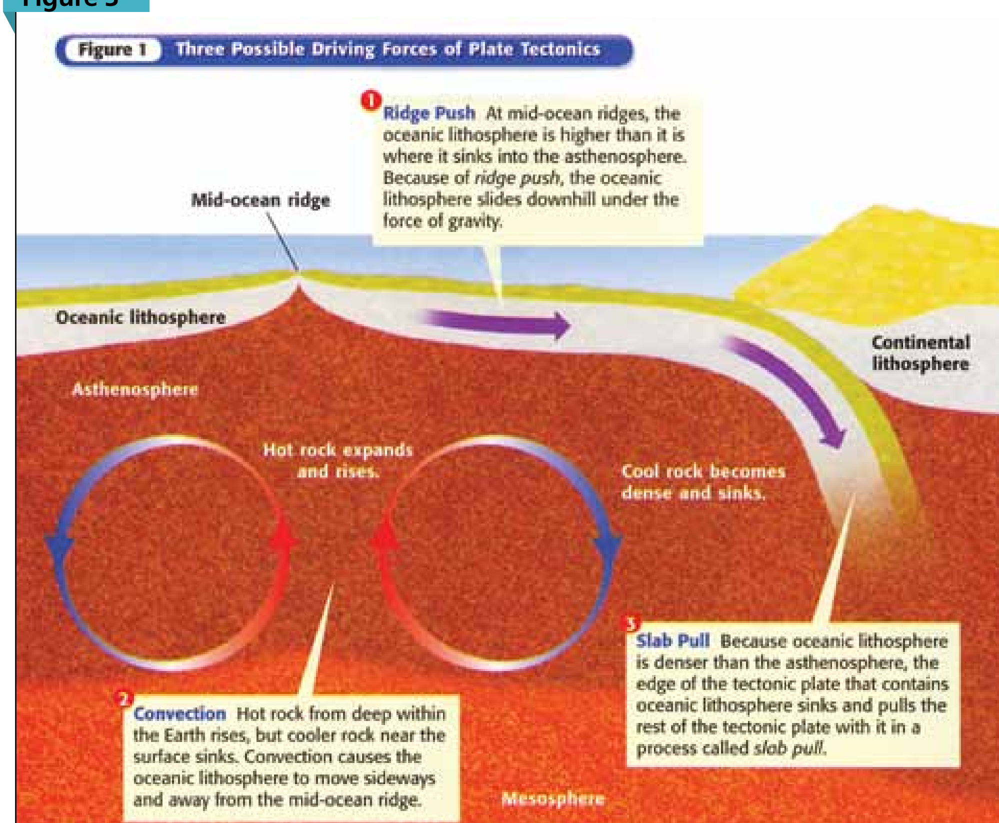
Encourage Students to Sketch

Scientists often draw as they make observations, or as they strive to develop ideas in conversations with other scientists. But students are typically asked to interpret visualizations created by others, rather than being asked to do their own sketching. Research reveals five reasons why active sketching is a good idea: it enhances engagement, deepens understanding, requires reasoning, forces ideas to be made explicit, and supports communication in work groups.[28] For example, Figure 4 (on page 31) shows a student's drawing from a project in which children between 10 and 13 used drawing to learn about evaporation. It is easy to see the engagement and reflection that went into creating it.[29]

Use Maps and Tools from Geographic Information Systems

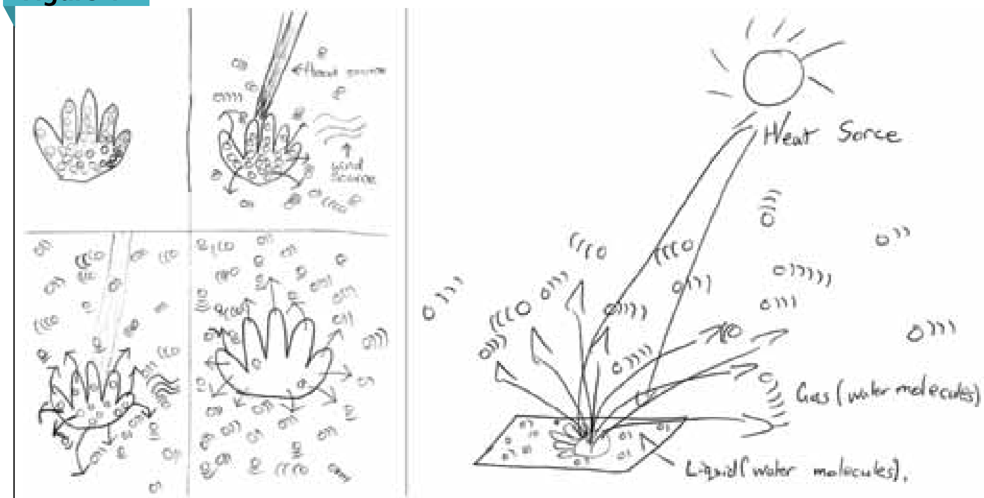
Geographic information systems (GIS) are technical tools of great power, involving overlays of maps of different distributions to create hypotheses and lay bare relationships. In fact, that is essen-

Figure 3



SOURCE: *HOLT SCIENCE & TECHNOLOGY: INSIDE THE RESTLESS EARTH*, TEACHER'S EDITION (HOLT, RINEHART AND WINSTON, 2007), 110.

Figure 4



SOURCE: SHAARON AINSWORTH, VAUGHAN PRAIN, AND RUSSELL TYTLER, "DRAWING TO LEARN IN SCIENCE," *SCIENCE* 333, NO. 6046 (2011): 1096–1097. REPRINTED WITH PERMISSION FROM AAAS.

tially what John Snow did—he overlaid a map showing cases of cholera with a map showing the locations of pumps. Learning GIS thoroughly requires several courses at the university level. But luckily, more user-friendly versions of GIS have been developed that can serve as tools in middle and high schools. One initial project was My World GIS, but most school-friendly GIS packages are now provided by the Environmental Systems Research Institute (Esri), which also supports user communities, archives sample lessons, and holds an annual conference.* The use of GIS for curriculum support is exemplified in the development of a Geospatial Semester† for high school students, in which the students are challenged to solve real-world problems using GIS techniques.[30] For example, one student worked on this question: What are the best locations for bears in a national park, given elevations, food sources, and the need to keep the bears reasonably distant from hiking trails? Another student investigated this problem: Where should we best locate wind farms on the East Coast of the United States, given shipping routes, bird migration patterns, and proximity to electrical grids? The teaching of history is also increasingly using maps and interactive mapping techniques.[31] Stanford University's Geospatial Network, for example, has used GIS to better understand the history of the Roman Empire in the context of the possible transportation routes of the time.‡ The "Roman road" acquires real meaning when analyzed in this way.

Support Students in Understanding Very Large and Very Small Spaces and Times

Understanding scale is fundamental in science education. Science is replete with very small distances (atoms) and very large distances (galaxies) as well as very short time scales (nanoseconds) and very long time scales (the age of the Earth). Social studies is less extreme, but time periods are long relative to students' lifetimes, spatial distances among cultures can be much greater than students easily understand, and economics can involve larger numbers than they usually encounter. Scale comprehension is difficult. However, scaling can be improved. My colleagues and I built on the fact that people typically represent magnitude information in a hierarchically organized structure, in which their lifetime, for example, is nested within the history of the United States, which is nested within recorded history, and so on.[32] We created an intervention to help students understand the age of the Earth. Half the students in an undergraduate introductory-level geology class were given multiple opportunities to progressively align time to a constant spatial scale in a linear representation and to locate all previous scales relative to the current scale. The other half of the class served as the control group. The intervention group demonstrated a more accurate sense of the relative durations of geological events and a reduction in the magnitude of temporal location errors relative to the control group. These findings are clearly only a starting point, but they suggest that cognitive science will soon be ready to help teachers communicate more effectively about the very challenging concept of scale.

Science, mathematics, and social studies are deeply spatial subjects. Currently, students who come to class with higher levels of spatial ability take more easily to learning in these areas, but this fact does not mean we cannot teach in a way that maximizes learning for all. Spatial ability can be improved both inside and outside the classroom, as well as by instruction in other subject areas, notably the visual arts. Spatializing the curriculum by including and explicitly teaching the spatial symbol systems that lie at the heart of science, mathematics, and social studies is an achievable and worthwhile goal. ☐

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*To learn more about My World GIS, see www.myworldgis.org/myworld. To investigate Esri software and support, see www.esri.com/Industries/k-12/education/educators.

†To learn more about Geospatial Semester, see www.isat.jmu.edu/geospatialsemester.

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(Continued on page 40)

Equality and Cooperation

Finland's Path to Excellence

By Jukka Sarjala

For the past decade, Finland has been lauded for consistently being a top performer on international assessments of student achievement. Having spent 25 years in the Ministry of Education, and then another 8 as director general of the National Board of Education, I am heartened by these accomplishments—but I am also concerned about how they are being interpreted by policymakers around the world. Much has been written about what we did from the mid-1960s to the early 2000s; the mechanics of our transformation have been well documented. Much less has been written about our values. But those values not only determine the overall shape of the reforms, they also sustain broad support when problems arise, guide day-to-day decisions, and ensure that all of the pieces—from curriculum to teacher preparation to assessment to budget allocations—fit together.

So, what are those core values? Equality and cooperation. Equality in opportunities *and* outcomes is what drives the first nine years of schooling. The national core curriculum for those nine years is challenging, but only about 4 percent of special education students attend separate schools. The rest have the capacity to be on grade level—as long as we provide expert teaching, intensive supports, and frequent remediation, as well as health and welfare services. This brings me to cooperation. Cooperation is what makes equality possible. Teachers, principals, counselors, parents, university professors, medical professionals, the teachers'

Jukka Sarjala was the director general of Finland's National Board of Education from 1995 to 2002. His career in education began in 1966 at Finland's Central Organization of Municipalities. From 1970 to 1995, he held various posts with Finland's Ministry of Education, including being head of the General School Section from 1981 to 1995.

ILLUSTRATIONS BY DANIEL BAXTER

union, government officials, and students themselves all have roles to play, and all support each other.

Excellence was a result, never an objective, much less a core value. But excellence comes from working together—for decades—to ensure that all children are well educated.

What is impressive about Finland's PISA (Programme for International Student Assessment) results is not that we provide a high-quality education, but that we provide an education that is both high quality and high equality.* To me, one of the most interesting findings of the 2009 PISA† (which focused on literacy, but also assessed mathematics and science, among 15-year-olds in 75 countries and regions) is this: while the average achievement level is quite high in Finland, the gap between high and low performers is relatively small.[1] The achievement gap between students from high- and low-income families is also relatively small.[2] (Finland also demonstrated excellence and equity on PISA in 2000, 2003, and 2006.)[3]

Perhaps even more important, PISA has revealed that the differences between schools in Finland are quite small.[4] It is of little consequence where students live and which school they attend. The opportunities to learn are virtually the same all over the country. The same kind of comprehensive basic education truly is provided to all students.

War Brings Clarity

Finland, a small country in northern Europe, is bordered by Sweden, Norway, and Russia, with Estonia just across the Gulf of Finland. Our small size and lack of major natural resources reinforce our cultural and philosophical commitment to equality. For us, equality is an economic necessity: the education system must be efficient to develop all talent reserves from all social classes and groups.

This necessity was especially clear at the end of World War II. In its peace treaty with the Soviet Union, Finland lost 10 percent of its arable land and forest resources, 12 percent of its total area, 13 percent of its national wealth, and 20 percent of its railway network. Finland's postwar social policy began in 1945 with the extensive measures taken to make living arrangements for returning soldiers and the roughly 12 percent of the population evacuating the territory taken by the Soviet Union.

Given this desperate situation, the Finns started building their country's future with two goals: securing independence and democracy, and building a welfare state that provides equal opportunities to all. Then and now, Finns agree that the main goals of social welfare are to prevent social problems; to assist those who are sick, elderly, or otherwise in need; and to encourage people's independence and initiative. The expansion of the welfare state was made possible by the country's economic progress: in the period from the early 1950s to the end of the 1980s, gross domestic product (GDP) grew, on average, by over 3 percent per year. By 1990, Finland's GDP per capita was the sixth highest in Europe (below Liechtenstein, Luxembourg, Monaco, Sweden, and Switzerland).[5] It remains quite high today.[6]

A major factor in Finland's rise from poverty after WWII was the efforts made by trade unions and employers' organizations to minimize labor unrest and conflict. Cooperation was a skill they learned, and came to revere, during WWII. To avoid any slowdowns in production, Finland's employers' organizations issued a declaration in which they acknowledged the legitimacy of the trade unions and accepted the Central Organisation of Finnish Trade Unions as an equal negotiating partner in labor market issues. This declaration was a turning point in Finnish history. It came soon after the Soviet Union invaded Finland at the end of 1939 (in what's known as the Winter War), and was essential to Finland's self-defense. Not only did the employee-employer unity help Finland remain independent, it solidified Finns' commitment to working out agreements.

After WWII, the situation in the labor market could have been very volatile if we had not had this wartime first step toward our modern agreement-oriented society. The severely war-torn nation needed peace in labor relations to recover and prosper. Those involved in politics focused on increasing the national product *and* on attaining social justice and equality. Conflicts continued to arise, but the underlying commitment to cooperation also continued to grow. Today, trade unions and employers' organizations are true social partners in Finland's national, social, and economic development.

> Our values sustain broad support when problems arise and ensure that all of the pieces—from curriculum to teacher preparation to assessment to budget allocations—fit together.

But I'm jumping ahead. To create a modern industrial society, Finland had to figure out what its commitment to equality and cooperation, and its economic necessity of continuing to increase GDP, meant for education policy.

Aiming for Equality

Until the 1970s, Finland's only educational accomplishment was a very high level of literacy. But one could easily argue that the credit for that should go to the church, not the education system. The Lutheran Reformation of the 16th century introduced the idea of vernacular education and the first Finnish-language ABC book. In the 1680s, the Lutheran Church decreed that the people be taught to read so that they could familiarize themselves with the Bible. By the end of the 19th century, the Finnish people were among the most literate in the world.

So, the education system had a good foundation to build on,

*PISA results are emphasized here because PISA provides extensive information on educational equity. However, it is important to note that Finland also is a top-performing country on PIRLS (the Progress in International Reading Literacy Study; see www.nces.ed.gov/pubs2013/2013010.pdf) and TIMSS (the Trends in International Mathematics and Science Study; see www.nces.ed.gov/pubs2013/2013009_1.pdf and www.nces.ed.gov/pubs2013/2013009_2.pdf).

†PISA tested students in 2012, but the results will not be available until the end of 2013.

but it was mediocre due to faulty thinking about students' abilities. After just four years of schooling, pupils were divided into two different streams of education. One provided primarily academic, theoretical subjects, while the other was practical and task-oriented. As the person charged with overseeing the dismantling of this two-stream system, I can flatly state that it had several moral and economic weaknesses:

1. Students had to make the choice that determined their career options at the age of 11. Such an early age is absolutely unsuitable for this decision.
2. Basic education was arbitrarily divided into two packages of different scopes and contents.
3. This inherently unequal system was made even worse by unfair distribution of resources: not only were the schools that provided better opportunities for further learning concentrated in towns, the supply of openings was insufficient.

To remedy all these weaknesses, radical school reform was necessary. After a lengthy political debate, the Finnish Parliament adopted the law on comprehensive school at the end of the 1960s. Although the parliamentary decision was more or less unanimous, there was a remarkable amount of skepticism in the mass media and among politicians as to where this reform might lead. The opponents of reform argued that the overall skill level would drop because the whole age group would never meet the expected standard.

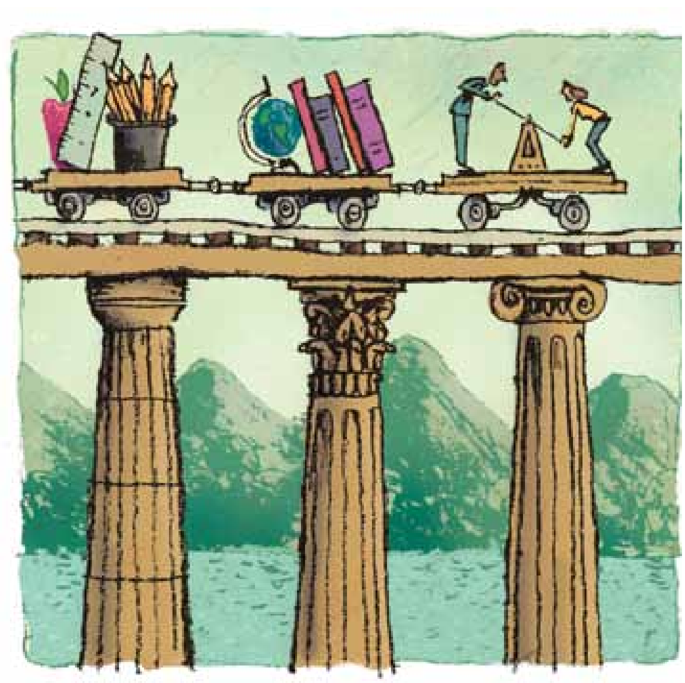
But the two-stream system was fundamentally unacceptable. In a democratic society, it is not tolerable for the basic civilization to depend on division into classes. Furthermore, the composition of each school must be similar to the structure of the whole society. It is very important that children from different social classes become accustomed to meeting each other in the common school.

In the 1970s, the two-stream system was replaced with *peruskoulu*, a nine-year compulsory, common school. To help make the transition to the common, comprehensive school, a detailed national curriculum for primary and secondary education was developed—with the help of hundreds of expert teachers—in the late 1960s. Textbooks were approved by central administration. The teaching process, including its contents and targets, were centrally determined. Even then, there was no US-style testing system, but we did have an inspection system. In addition, we made the transition slowly, starting in the early 1970s in the sparsely populated northern part of the country, and taking several years to bring peruskoulu south.

Today, virtually all students—more than 99 percent—complete peruskoulu. During the first six years, instruction is usually given by a generalist elementary teacher, who teaches all or almost all of the subjects. Then, during the last three years, the different subjects are taught by specialized subject teachers. For children, teaching, educational equipment (textbooks, for example), and welfare services (including health, dental, and counseling services) are free of charge. In addition, pupils get one free warm meal a day. As a rule, transportation is arranged by the municipality for distances of three miles or more.

For the most part, all pupils during the first six years receive the same academic content and teaching. In the last three years, the curriculum includes common subjects and some optional subjects freely chosen by the pupils. Optional studies may include courses in, for instance, foreign languages, sports, and art and music, or integrated, in-depth courses or applied studies in the common subjects. Students also have the option of attending peruskoulu for a 10th year.

Despite the concerns raised when we created peruskoulu, now there are very few grade repeaters in Finland. Why? First, repeating a grade means extra costs for the school and is inefficient. Most pupils have at least one strong subject, so it is unnecessary to repeat all subjects. Second, repeating can be embarrassing; when it turns students into reluctant learners, it is counterproductive. To avoid the need for grade repetition, pupils are given the necessary support all through the school year in those subjects that they find difficult to learn.



Since our goal is equality of outcomes, peruskoulu is for each child; it must adjust to the needs of each child. While peruskoulu began with a detailed national curriculum (which was helpful during such a radical transformation of the school system), it soon became clear that teaching heterogeneous groups requires expertise and flexibility. In the 1980s, teacher preparation was made much more rigorous, and then in the early 1990s, a profound change in curricular philosophy and practice took place. The national curriculum was changed to be more flexible and less detailed, and students in the middle and upper grades were given more optional subjects. And, the national textbook approval process and the inspection system were both abolished. Now, we have a school-based, teacher-planned curriculum (guided by the national curriculum framework) along with student-oriented instruction, counseling, and remedial teaching. With all these supports, Finnish teachers set high standards for all students. Even on the primary level, teachers stress the importance of demanding cognitive aims.

After completing peruskoulu, approximately 95 percent of students voluntarily continue on to upper-secondary education—either general or vocational. About half of the students opt for general upper-secondary education. Since 1982, instruction in these schools has been divided not by grade levels, but by courses, with each course consisting of about 38 lessons. Consequently, pressures for all students to proceed at the same pace have been eliminated. The school year is usually divided into five or six periods. A separate timetable is drawn up for each period, concentrating on certain subjects. These courses are designed to take three years, but progress in studies is individual. While some students are able to finish in two years, others take four years. This is just one more example of our pursuit of equal results. Students do differ—some are faster than others, some have more responsibilities outside of school than others—but all can succeed if the education system is designed to provide real opportunities.

At the end of upper-secondary school, students may take a matriculation examination that is used for university admissions. The matriculation examination is drawn up nationally, and there is a centralized autonomous body to check its individual tests according to uniform criteria. Students must take tests in at least four subjects; one of them is obligatory for everybody: the mother tongue (Finnish, Swedish, or Sami). For their three other tests, students may choose from a second national language (Swedish or Finnish), a first foreign language (mainly English), mathematics, and general studies.

In the vocational upper-secondary schools, training in practically all occupational fields is offered to students ages 16 to 19. Vocational education and training cover seven sectors of economic life, including 112 different study programs. Every student must spend at least half a year at a real workplace engaged in on-the-job learning.

Although the upper-secondary options sound divided, it is possible to move from vocational to general academic studies (and vice versa). Such movement is also possible in higher education, as Finland has both universities and polytechnics offering a range of degrees.

Succeeding through Cooperation

Two government agencies oversee education: the Ministry of Education and the National Board of Education. The ministry is responsible for education policies, including preparing legislation for parliament and negotiating budget allocations for education. The board is responsible for policy implementation. It is an expert body responsible for the development of educational objectives, contents, and methods, which it codifies in the national core curricula it develops for the different types of schools. The board also evaluates outcomes.

Although there is no student testing similar to the accountability-focused testing done in the United States, Finland conducts studies to enhance educational quality. Since 1998, the National Board of Education has completed two such evaluation projects. These national evaluations were designed to produce information about the quality, content, and outcomes of education and vocational training in light of the objectives of society, work, and the individual. Instead of testing all students, representative samples (about 5–10 percent of students) are tested. Information is also gathered about schools as learning environments and students' learning abilities and motivations.

Finland's municipalities (there are no US-style state-level governments) are responsible for running the peruskoulu and upper-secondary schools. Education funding is divided between the central government and the municipalities. The original idea was that the central government subsidy would be, on average, 57 percent of the costs while the municipal contribution would average 43 percent, but the share of municipal funding has increased in recent years.* In addition to the schools, the municipalities are responsible for hospitals, health centers, and social welfare. This is important because the national core curriculum obliges municipalities and schools to cooperate with social and health authorities, especially in pupil welfare matters.

This overview of the education system's structure is helpful, but what really matters is how all the different individuals and groups work together. We share the goals of equal opportunity and equal results—and we know such lofty goals can only be accomplished through cooperation.

Unlike the United States, where there are only two major political parties and one party can work to take power from the other, Finland has a multiparty democracy that makes collaboration and compromise essential. Therefore, just as educational equality is an economic necessity, cooperation throughout the education sector is a political necessity.

For decades, ministers of education have understood that carrying out a reform will be infinitely easier if the experts from the teachers' union have been involved.

Fortunately, since the development of peruskoulu, there has been an exceptionally broad cultural and political consensus about the main lines of national education policy. We believe in equality, and our PISA results tell us that our cooperative approach to child development and well-being is working.

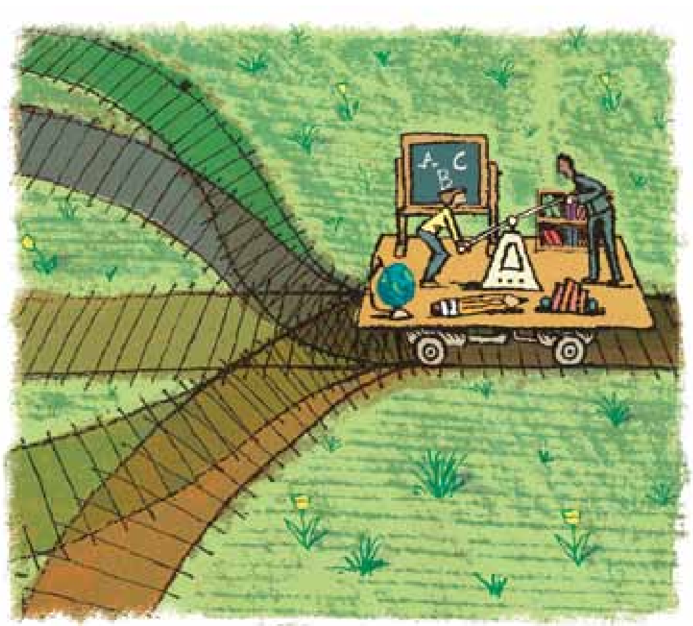
Unions as Partners

As discussed earlier, unions have been recognized since WWII as partners in national development. Today, Finland has one of the highest rates of union membership in the industrialized world, with 70 percent of employees organized in trade unions.[7] Unlike in the United States, in Finland unions of highly educated professionals are quite common. A large central organization of such unions—the Confederation of Unions for Professional and Managerial Staff—has affiliates in many different fields, including architects, doctors, lawyers, professors, scientists, officers, priests, nurses, and teachers. With its small size, multiparty government, and high unionization rate, Finland is a negotiation society.

*For citizens to get equal welfare services, the national government subsidizes the municipalities. In the poorest municipalities, the government subsidies are the greatest source of income, greater than their tax levy from the residents.

The unions for all types of trades are active participants in policymaking. They submit recommendations to the government and parliament concerning employment and social affairs, education and training, taxation, energy policy, and the evolution of work and business life. Employers, employees, and government officials agree that it is better to all sit around the same negotiating table than to have a crisis in the labor market.

Finland's teachers' union, the Trade Union of Education, is especially strong. There used to be several teachers' unions; about three decades ago they merged, multiplying their political importance and bargaining power. Although membership is voluntary, over 95 percent of teachers belong to the teachers' union. All types of teachers belong to the same organization: teachers responsible for daycare, in peruskoulu, in upper-secondary schools, in vocational schools, and in adult education. (The only exception is university professors, although many university lecturers are members of the teachers' union.) Those studying to become teachers and retired teachers also belong to the union. What is exceptional to many outside observers is that headmasters also belong to the teachers' union. In Finland, headmasters are all former teachers—and in the smaller schools, many still retain some teaching duties.



With such a high membership rate, the teachers' union is obviously powerful, but it is also very highly respected and welcomed in policymaking. For decades, ministers of education have, without fail, understood that carrying out a reform will be infinitely easier if the experts from the teachers' union have been involved in the preparatory work for the reform.

Beyond this practical concern, in Finland's cooperative culture it is customary to have education policy matters decided upon collectively. When a reform is proposed, the minister of education normally appoints a committee in which all parties that will be touched by the reform are represented. In general, the representatives from the teachers' union and municipalities are called upon, and representatives of parents and student organizations are invited to participate.

Ongoing communication and cooperation are built into the policymaking structure: the National Board of Education has a board of advisors whose members are appointed by the national government for a term of four years. For its entire existence, the board of advisors has included representation from the teachers' union and the municipalities.

Cooperation between policymakers and the union may be facilitated by the fact that while policy happens on the national level, teachers are employed by—and the union negotiates with—the municipalities. But even these negotiations happen in a collaborative structure with a cooperative mindset. Instead of each municipality negotiating a local contract, the municipalities have an organization, the Commission for Local Authority Employers, that engages in collective bargaining with the teachers' union, resulting in the "Municipal Collective Agreement." This fact has great significance in principle and practice. Dialogue between the ministry and the teachers' union mainly touches issues that have to do with the provision and content of education. If the teachers' union and the ministry had to negotiate about both pay and education policy, it is unlikely that the two would cooperate as well and as openly as they do now.

At the same time, there is a connection between reforms in education policy and teachers' pay. Changes may add to teachers' workloads or alter their professional requirements. So it is only natural that, prior to implementing the reforms, there has to be an agreement as to how the new requirements will be accounted for in their pay. *If there is no such agreement, the reform will not be introduced.*

Across Finland, teachers and administrators, as well as union officials and policymakers, share a concern about our learning results and especially about the welfare of our children. All regard the support and guidance needed by students in learning and in their personal development as vital. We want our schools to be academically inspiring and demanding, while at the same time safe, friendly, and caring. If Finland holds any lessons for the United States, the main one would be this: when everyone cooperates to achieve equality, inequality can be dramatically reduced and excellence can be attained. ☐

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Common Ground on Class Size

BY RITVA SEMI

What is the optimal class size? It's a question that educators and policymakers in many countries, including Finland, continually ask themselves. Opinions vary on what student-to-teacher ratio works best. Often, educators are told that it makes no difference if one or two additional children are placed in their classrooms. When teachers raise concerns about increased class sizes, they are sometimes told that their teaching skills are weak and in need of improvement. Some CEOs may believe that paying teachers more will resolve the issue. But teachers know that salary increases alone cannot make up for the lack of individualized attention students receive in crowded classrooms.

Even in Finland, where cooperation and equality have paved the way for high educational achievement, teachers and their unions must remain vigilant in helping to keep class sizes reasonable. Finnish teachers recognize that besides teaching the curriculum and meeting instructional targets, they must take into account each student's strengths and weaknesses. They know they can only attend to students' needs if class sizes do not grow out of hand.

Many foreign visitors to Finland notice that the student-teacher ratio in Finnish primary schools is rather good; on average, there are 20 students to one teacher in grades 1 through 6. However, class size varies considerably among schools and municipalities. Some primary school classes have 30 students, while others have only 10. How is this possible?

Historically, national education legislation determined the maximum class sizes, but in the 1990s, new legislation left the decision to the municipalities, which had demanded such a change. During the good economic times of the 1990s, Finland's teachers' union, the Trade Union of Education (where I work as a special advisor), was willing to trust the municipalities to prioritize education and children. One reason for that willingness was that a legal limitation on class sizes for children with special needs remained intact.

Over time, however, the issue of class size became problematic. Teachers did not like the inconsistency; some were happily working in small classes, while others had classes that were too big. In the beginning of 2000, the situation became unworkable. The municipalities had financial problems that resulted in bigger classes in the primary schools. In the union, we put this issue at the top of our agenda and considered our options. Would it be better for the municipalities to continue to have decision-making power so that union members could then lobby their local decision makers? Or should we demand new national legislation? After our analysis, we decided to demand legislation requiring that each primary school class have no more than 18 children.

To that end, the union began to lobby members of parliament and members of various ministries, especially those members who had previously been teachers. We also worked closely with civil servants in the Ministry of Education and the National Board of Education to convince them of the importance of smaller class sizes. And we contacted the health care sector, child welfare organizations, and universities for their support. In this way, we created public awareness of our message, and little by little, decision makers began to listen to us. The Finnish Parents' League was a strong partner. Parents joined us in lobbying at the municipal level by directly contacting their municipal council members. Many of these decision makers have children who attend the public schools, which helped them understand the importance of this issue.

Our efforts to reach out to the public have paid off. During the last four years, the government has allocated additional funds to municipalities in order to reduce class sizes. The municipalities must apply for these funds from the Ministry of Education and then keep the ministry apprised of their class sizes. We realize that government funds alone are not enough to keep class sizes reasonable permanently, but they do signal that our politicians recognize that class size matters and that students and teachers will encounter problems when classes are too large.

Last year, the minister of education announced his support for the union's advocacy for legislation limiting class size.

In some cases, where class sizes cannot be reduced by creating more classrooms, two teachers are assigned to teach within the same class. We recognize that the ways to keep class sizes manageable will vary, and we are open to creative solutions that will allow teachers to give students the attention they need.

Last year, the minister of education announced his support for the union's advocacy for legislation limiting class size. While this is a major victory for Finnish education, the fight for equal educational opportunity is not over. Even if we achieve new legislation, the challenge of providing the best education for all children will never really end. It's a constant struggle in which the union works step by step to find common ground with key partners. Cooperation leads to the best results. ☐

Ritva Semi, a former preschool teacher, is the special advisor to Finland's Trade Union of Education, where she focuses on education policy, international relations, and lobbying.

Increasing IQ

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School Ties

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says, so too should teacher preparation programs focus on subject-matter expertise plus child development, a basic science of teaching. Though he has yet to convince these institutions that teachers are child developers, he remains undeterred. "That's work to be done," he says, adding in his unassuming way, "I'm around until that happens."[30] ☐

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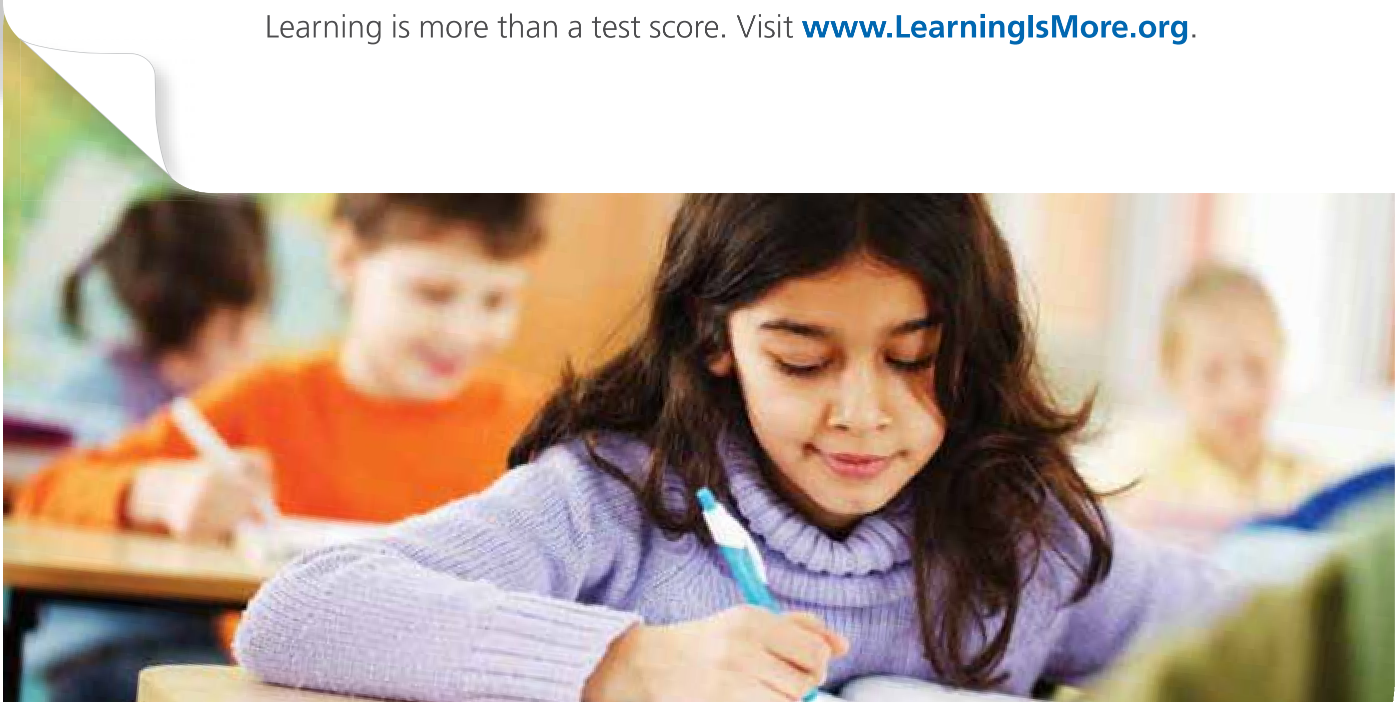

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