Schools and the *g* Factor

by Linda S. Gottfredson

In the world of the American public school, few subjects are more controversial than intelligence. If there's a tension in American society between the ideal of equality and the pursuit of meritocracy, that tension escalates into the equivalent of a migraine headache in the schools. Called upon to produce young people fully prepared for citizenship and ready to meet the competitive challenges of the modern economy, the schools are also seen, at the same time, as the nation's last best hope to level the playing field and ensure equal opportunity for all. In no American institution is the egalitarian strain of the American creed stronger. And the very notion that school performance is strongly influenced by general intelligence—a quality partly inborn—seems to contradict this deeply held ideal of equality.

During the past few decades, the word *intelligence* has been attached to an increasing number of different forms of competence and accomplishment—emotional intelligence, football intelligence, and so on. Researchers in the field, however, have largely abandoned the term, together with their old debates over what sorts of abilities should and should not be classified as part of intelligence. Helped by the advent of new technologies for researching the brain, they have increasingly turned their attention to a century-old concept of a single overarching mental power. They call it simply *g*, which is short for the general mental ability factor. The *g* factor is a universal and reliably measured distinction among humans in their ability to learn, reason, and solve problems. It corresponds to what most people mean when they describe some individuals as smarter than others, and it's well measured by IQ (intelligence quotient) tests, which assess high-level mental skills such as the ability to draw inferences, see similarities and differences, and process complex information of virtually any kind. Understanding *g*'s biological basis in the brain is the new frontier in intelligence research today.

The *g* factor was discovered by the first mental testers, who found that people who scored well on one type of mental test tended to score well on all of them. Regardless of their contents (words, numbers, pictures, shapes), how they are administered (individually or in groups; orally, in writing, or pantomimed), or what they're intended to measure (vocabulary, mathematical reasoning, spatial ability), all mental tests measure mostly the same thing. This common factor, *g*, can be distilled from scores on any broad set of cognitive tests, and it takes the same form among individuals of every age, race, sex, and nation yet studied. In other words, the *g* factor exists independently of schooling, paper-and-pencil tests, and culture.

Though there has been intense controversy about IQ tests over the years, psychologists continue to see them as valid and useful gauges of student potential.

No longer routinely administered to whole school populations—*achievement* tests are much better suited to tasks such as grouping students for instruction—they are widely used by school psychologists in individual assessments to determine, for example, whether a child who is having difficulties in school has a learning disability or some other problem. As a practical matter, all good standardized tests of IQ and achievement end up ranking students in much the same way because *g* is the major predictor of academic achievement.

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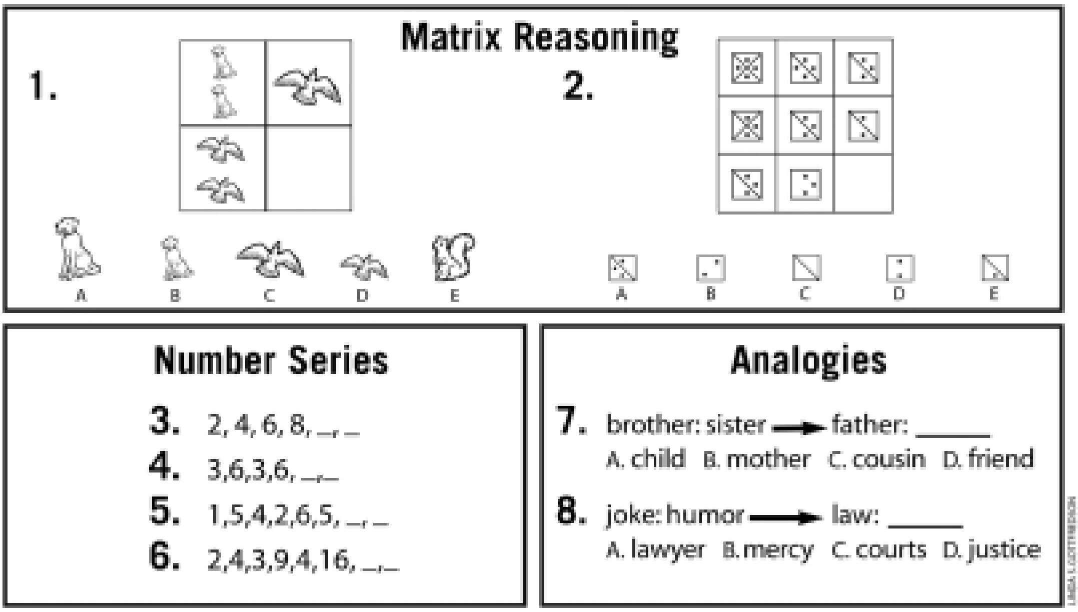
During the 1960s and 1970s, educators launched several ambitious efforts to raise the IQs of disadvantaged youngsters in experimental preschools. The results were discouraging: Even when it was possible to raise the IQs of young children, the gains never translated into comparable gains on achievement tests, and the IQ gains evaporated soon after children left the programs. The disappointing results helped fuel an attack by some researchers on the very idea of IQ and *g* and also contributed to the rapturous reception for the theory of "multiple intelligences" that emerged in the 1980s, notably in Howard Gardner's *Frames of Mind* (1983). To replace the idea of general intelligence, Gardner, a developmental psychologist at Harvard University's Graduate School of Education, proposed seven coequal intelligences: linguistic, logical-mathematical, visual-spatial, musical, bodily-kinesthetic, interpersonal, and intrapersonal (he later added naturalist, to make eight).

Gardner's theory offers a useful reminder that there are many human abilities and forms of accomplishment, and it puts new labels on some of the most common of them. Thus, good athletes have bodily-kinesthetic "intelligence," and self-help celebrities such as Oprah Winfrey have intrapersonal "intelligence." Gardner takes the seemingly commonsensical notion that people meet the world in different ways and elevates it into a comforting accolade: Everybody is smart in some way.

In the classroom, the theory seems to give teachers a new language to describe their perceptions of students and classroom life. Teacher guidebooks such as *Teaching and Learning through Multiple Intelligences* (1995) suggest using the eight intelligences as different "entry points" for leading students into a single lesson. To teach a unit about photosynthesis, for example, a teacher might have all students read a description of photosynthesis to provide an entry point for the linguistically intelligent, have the class compare plants grown with and without sufficient light to reach children with naturalist intelligence, engage the logical-mathematical students by asking the class to prepare a timeline for the

>LINDA S. GOTTFREDSON *is a professor of education at the University of Delaware and an affiliated faculty member in its University Honors Program. She is the author of many articles on the role of intelligence differences in school, work, and everyday life, and the editor of several special journal issues on these topics, including an issue of* Intelligence, *"Intelligence and Social Policy" (1997).*



IQ tests use questions like those above to measure intelligence. Here, test takers are asked to identify patterns in images, numbers, and words, and the patterns differ in degree of complexity.

Answers: 1.A; 2.D; 3. 10, 12; 4. 3,6; 5.3,7; 6.5,25; 7. B; 8. D

steps of photosynthesis, require painting those steps to aid the visually-spatially inclined, have students role-play the "characters" in photosynthesis to help the bodily-kinesthetic child—and so on, until all eight intelligences have been accommodated.

There's something very appealing about this scenario, but it's unlikely that students kept so busy walking through multiple doorways will have much time to advance very far once they get through them. As one biology teacher told me recently, the multiple intelligence approach may allow students with special talents to express their understanding in ways that are personally gratifying, but science is inherently analytical, and understanding it ultimately requires the application of strong reasoning and analysis skills—period.

However much we might wish that there were many distinct forms of mental ability, a century of research has found none as widely useful as *g*. Neither of the two major multiple intelligence theorists, Howard Gardner and Yale University's Robert Sternberg, disputes the existence of *g*, only its preeminence among mental abilities. There are, to be sure, many different human mental abilities, but they are neither independent of one another nor equally useful.

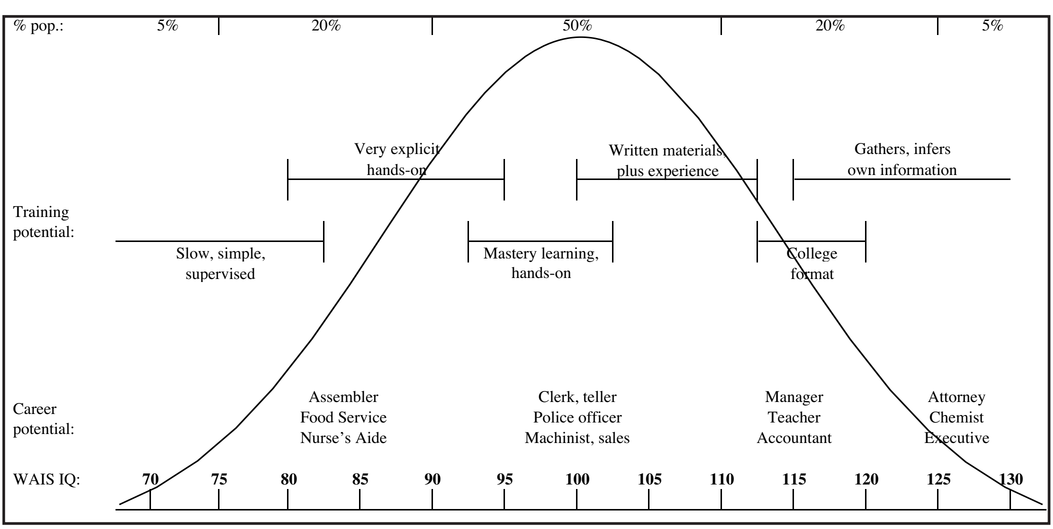
THE MULTIPLE INTELLIGENCE APPROACH SUGGESTS THAT EVERYBODY IS SMART IN SOME WAY.

The past 100 years of research has yielded a body of knowledge that virtually all those working in the field accept as valid, despite their various perspectives and the controversies surrounding this issue. Differences in IQ among young children can be traced in about equal parts to differences in their genes and their environment. (A special panel named by the American Psychological Association to summarize the state of knowledge on intelligence in 1995 noted that the lowest possible estimate of the genetic component is about 40 percent.) Genetic differences become a bigger source of intelligence differences as children age. Behavior geneticists suspect the reason is that as they achieve more independence, children are more able to select and shape their environments, which then shape them. The power of genes can be seen in the fact that identical twins reared apart are more alike, after meeting in adulthood, in IQ, brain function, personality, and many other traits and behaviors than fraternal twins raised in the same home.

Genes probably work their influence by shaping various metabolic, electrical, and structural features of the brain. For example, the brains of people with higher IQs tend to have a relatively lower rate of energy use (as measured by glucose metabolism) while solving problems, and quicker and more complex brain waves in response to simple perceptual stimuli such as lights and sounds. Researchers have long debated whether people with higher IQs have bigger brains, and the latest findings, based on studies with new brain-scan technology, show that they do. Distinctions in *g*, or general intelligence, are evidently as much a fact of nature as differences in height, blood pressure, and the like.

A great deal of research also shows that *g* matters well beyond school. In *Who Gets Ahead?* (1979), sociologist Christopher Jencks and his colleagues reviewed many large studies and showed that an individual's IQ predicts his occupational level and income in adulthood (as well as years of schooling completed) better than his father's education or occupation does. The influence of *g* varies in dif-

The IQ Influence



IQ is not destiny, but many studies show that different levels of IQ are highly correlated with certain kinds of real-world outcomes, as suggested in this diagram showing the distribution of IQ in the U.S. population. About 95 percent of the population has IQs between 70 and 130.

ferent realms of life—schooling, work, parenthood—simply because some are less cognitively demanding than others. Some life outcomes are also shaped more than others by such factors as one's noncognitive traits (ambition, extraversion) and decisions that others make about the individual (college admissions, hiring, pay raises). Yet the evidence of *g*'s pervasive and lasting impact is well documented, especially when it comes to life's more complex tasks. For example, personnel psychologists Frank Schmidt and John Hunter reviewed thousands of studies that were conducted over 85 years in many different companies, government agencies, and military settings, and that used everything from handwriting analysis to job tryouts to forecast job performance. Their meta-analyses of these data showed that mental tests predict on-the-job performance better than personality, integrity level, experience, and education. In the *Journal of Personality and Social Psychology*, I recently published a study showing that both IQ and adult functional literacy correlate in the same pattern with a wide variety of adult outcomes, including health and longevity (in part because maintaining one's health requires learning and adaptation), all regardless of social background. In that same journal, University of Edinburgh psychologist-physician Ian Deary and his colleagues reported on a study showing that each one-point increase in IQ when the study participants were 11 years old predicted a one percent decrease in mortality by age 50. If IQ is "book smarts," it is clearly much more besides.

DRAWING A BEAD ON EXACTLY WHAT *g* IS AND HOW IT WORKS REMAINS A DIFFICULT TASK.

Drawing a bead on exactly what *g* is and how it works remains a difficult task, but specialists in mental testing now commonly agree that *g* sits atop a hierarchy of mental abilities. Most of these researchers have adopted the three-level hierarchy developed by educational psychologist John B. Carroll in his monumental *Human Cognitive Abilities* (1993). After statistically extracting the common ability factors from more than 450 earlier studies in which multiple tests had been administered to the same individuals, Carroll classified all abilities into three levels.

At the highest level, Stratum III, Carroll found evidence of only one ability: *g*. In Stratum II, he documented eight broad abilities involving language, reasoning, spatial visualization, auditory perception, memory, and cognitive speediness. Stratum I includes relatively specific mental abilities, such as memory span and reading comprehension.

All Stratum II aptitudes are highly correlated with one another. A person with weak language ability, for example, is very unlikely to be strongly endowed with another Stratum II ability, such as spatial visualization. Tests of these abilities show that they are highly correlated both with one another and with *g*. All consist primarily of *g* plus a dose of some more specific ability. As Carroll puts it, the Stratum II abilities are all different "flavors" of *g*. Despite many attempts, nobody has ever succeeded in creating tests that measure these abilities without simultaneously measuring mostly *g*.

Most IQ test batteries are composed of about a dozen subtests (involving, for example, vocabulary, sentence completion, number series, matrices, and similarities) of abilities near the Stratum I level. A person's scores on each are added together to produce an IQ score. But one's intuitive sense that the Stratum I abilities are the "building blocks" of intelligence is incorrect. The basic element at each level is *g*. A Stratum II ability is made up of *g* plus some more specialized ability. A Stratum I ability is produced by adding an even more specialized ability to this mix. Each lower stratum thus includes increasingly numerous and more complex amalgams of skills that are targeted to fewer and more specific kinds of tasks.

WHERE THERE'S NOTABLE TALENT, THERE'S ALWAYS A HIGH LEVEL OF *g*.

Researchers have drawn quite a clear picture of human mental abilities. For instance, the technical manual for one widely used test, the Stanford-Binet IV, shows that the Stratum I ability "vocabulary" is about three parts *g*, plus two parts a special language facility that makes its entrance at the Stratum II level, plus one part a vocabulary-specific ability entering at Stratum I. Similarly, the Stratum I ability "memory for sentences" is roughly two parts *g*, one part each special verbal and memory abilities entering at Stratum II, and one part an ability specific to Stratum I.

Carroll points out that four of Gardner's intelligences (linguistic, logical-mathematical, spatial, and musical) correspond to four Stratum II abilities. They aren't independent abilities, as Gardner asserts, but rather are linked to one another and to *g*. Three of Gardner's four other intelligences fall largely outside the cognitive realm, while the fourth (naturalist) is too diffuse to analyze. Gardner's intrapersonal and interpersonal intelligences seem to be matters mostly of personality, while his bodily-kinesthetic intelligence reflects mostly psychomotor strengths such as eye-hand coordination. These are useful qualities, to be sure, and they can help a person get by in the world, but they will not help that person *apprehend* the world. For that you need *g*.

Because gifted children tend to have more jagged ability profiles than children of average or below-average intelligence—think of the classic math wiz who is not as dazzling in subjects such as history that depend on verbal reasoning—Gardner can allow educators to draw the inference that every child can be smart in some way. But the math wiz will still have relatively strong verbal skills. Where there's notable talent, there's always a high level of *g*. Gardner implicitly acknowledges this when he concedes that all the individuals he names as exemplars of his eight intelligences probably had IQs above 120 (the 90th percentile). His eight domains of achievement may enrich our lives, but they do not represent independent faculties of mind or alternate pathways to mastering school curricula, jobs, or everyday tasks.

Gardner's theory has been protected from direct contradiction by his failure to develop any formal tests of his proposed intelligences. (He believes that assessments should be more holistic.) None of the assessments that schools currently use to identify students' multiple intelligences would satisfy the standards for testing jointly promulgated by the three major professional organizations in the field. Mindy Kornhaber, a Gardner collaborator now at the University of Pennsylvania, evaluated three major methods for identifying gifted students in terms of multiple intelligences and concluded in *In the Eyes of the Beholder* (2004) that they are not "technically strong enough to withstand modest scrutiny." Among other problems, some use checklists that seem to assess interests rather than abilities, and none have clear enough procedures for raters to agree on who is gifted or in what way.

In the education textbooks used to instruct tomorrow's teachers, however, one doesn't get any sense that ample evidence favors a single broadly useful intelligence rather than multiple independent ones. Textbooks written by educational psychologists tend to report the facts about IQ with reasonable accuracy, but they systematically minimize or muddy the measure's relevance. For example, they will report that IQ tests predict academic achievement quite well, but then imply that this fact need not be taken seriously because, after all, that's precisely what IQ tests were first developed to do. IQ, they say, represents only a narrow academic ability, "book smarts," and it matters little outside school. All of this is often topped off with the closing argument that IQ does not capture everything important about the human mind and soul—as if intelligence researchers have ever said otherwise.

The presentation of facts may be muddied but the larger message is clear: Multiple intelligence theories are the modern alternative—the antidote—to outmoded "unitary," "narrow," and "exclusionary" theories of ability. Textbooks create an aura of scientific superiority for the new theories by substituting their advocates' certitude for evidence, and the absence of any pertinent research for readers to critique leaves the claims pristine. Take, for example, Laurence Steinberg's *Adolescence* (2002), a textbook assigned to future teachers at the University of Delaware's School of Education, where I am on the faculty. Steinberg blithely asserts that "even the best IQ tests used today measure only a very specific type of intelligence," and that there are ways of "being equally intelligent as individuals who score high on IQ tests—but intelligent in a different way."

Multiple intelligence theory gathers unto itself all good things. Commonly accepted pedagogical principles that have no necessary relation to multiple intelligence theory—that teachers should go beyond rote learning, appreciate students' strengths and weaknesses, use different modes of presenting information, and believe that all students can learn—are described as if they were the hallmarks of the multiple intelligence approach alone. The theory's proponents link harmful, distasteful, and patently false beliefs with IQ—for example, that IQ is immutable, environments do not affect learning, some children cannot learn, and IQ is a measure of human worth. Readers are left with the impression that it is morally suspect to favor "nar-

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row" views of intelligence, which are "elitist," and "segregate" or "privilege" some students. For all their rhetoric about diversity, proponents of multiple intelligence betray a deep uneasiness with difference.

The vogue for multiple intelligences is just one manifestation of an attack on "ability grouping" and "curriculum tracking" in the schools that has been underway for decades. Federal enthusiasm for programs for gifted children, for example, spiked after the Soviet launch of Sputnik in 1957, and then evaporated in the early 1960s. (Since that decade, scores by America's highest-performing students have fallen on national tests such as the SAT and the Stanford Achievement Test.) Access to advanced placement courses and programs for the gifted is being opened up in the name of inclusion, and as a result, many programs are sacrificing their rigor and distinctive curricula.

Grouping students by ability level in classes or in small groups within classes offers the promise of differentiating instruction to better fit diverse student-ability levels (though in reality that promise is seldom fulfilled). As recently as the 1980s, between 80 and 90 percent of eighth and tenth graders were being taught in "ability-homogeneous" classrooms. Twenty-two percent of seventh graders were in homogeneous classes for all subjects, and 47 percent for some subjects. About 90 percent of elementary schools at the time were using within-class grouping for at least one subject, and 70 percent were using between-class grouping. I'm aware of no more recent surveys, but observers agree that increasing numbers of schools are attempting to eliminate grouping and tracking and also to "mainstream" both gifted and special-education students into regular classrooms.

The effects of this trend, so cavalierly endorsed by those who fantasize classrooms full of pluralistically smart students, are more candidly described in textbooks for teaching instructional strategies. The text we use at the University of Delaware, *Looking in Classrooms* (2003), declares that "educators' thinking has progressively moved away from policies of exclusion and homogeneous grouping toward an emphasis on the value of diversity, policies of inclusion, and practices that meet the needs of all students." But *Looking in Classrooms* is very clear about the realities teachers face. It paints a sobering portrait of the "heterogeneous" classes created by the demise of grouping, tracking, and special classes for disabled or gifted students. Its case example is a sixth-grade classroom with 26 students from varied racial and ethnic backgrounds and family configurations. Three of the students spoke little or no English, and one of them was legally blind. Among the 23 who could be validly tested, the grade equivalents for reading ranged along a breathtaking span from 2.3 to 10.5; two students were gifted. Such large disparities are common in heterogeneous junior-high classrooms. As *Looking in Classrooms* describes it, the teacher's solution for orchestrating appropriately different

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instruction of the same "key ideas" for her 26 highly diverse students calls for an effort that is nothing short of heroic. It's as if teachers today must not only work in a one-room schoolhouse but also individualize instruction for all their charges so that all can master the same (trimmed down) curriculum in lockstep.

Degrouping, which is meant to prevent the social distinctions that arise when students are segregated by ability level, can create even bigger distinctions. Placing the intellectually unequal in proximity forces students to observe their differences in capability more directly. It is hard to miss the fact that some students typically learn two to five times faster than others, or that some are reading difficult books while others struggle with simple ones. All teacher textbooks therefore emphasize, at least implicitly, that a teacher's first concern in mixed-ability classrooms must be to ensure that students perceive each other as social equals.

THE NEW "HETEROGENEOUS" CLASSROOM CALLS FOR HEROIC EFFORTS BY TEACHERS.

Looking in Classrooms reviews research on some of the familiar techniques for putting this into practice, such as cooperative learning and peer tutoring. These are strategies for having students interact across ability lines in ways that enhance the performance of low-ability students without stigmatizing them for their lesser achievement. Proponents cite experimental studies showing that these methods do indeed improve performance among low-achieving students, while somewhat enhancing, or at least not impairing, performance among more-able students. Only the fine print reveals that the experiments deal just with basic skills, not with higher levels of understanding. Like other textbooks, *Looking in Classrooms* mentions highly able students only when discussing how to "lean on" them for tutoring of their less-able classmates.

In reality, these instructional strategies for mixed-ability classes preclude precisely what helps the more-able students most: accelerating their curriculum, allowing them to interact with their intellectual peers, and making them work hard. Accelerated and compacted curricula can double the speed at which highly able students advance, but such differential treatment is decried as elitist and exclusionary. As targeted instruction for gifted children is reduced in the public schools, their parents must increasingly rely on opportunities outside regular school settings. Summer programs for talented youngsters at universities, for example, are routinely able to advance the top one percent of 13-year-olds one full year in biology, chemistry, physics, Latin, or math in the space of only three weeks.

Tracking and grouping persist in American schools despite the strong pressure for their elimination. Math and science teachers remain strong advocates of tracking, and many parents lobby hard for the programs they think their children need. There's also significant pressure from above: College and university admissions offices want to be able to identify students who have taken demanding courses. And there's the inescapable reality that it's very difficult to produce good results for *any* students when they are placed in heterogeneous classes. As James A. Kulik of the University of Michigan reported in the *Handbook of Gifted Education* (2003), "On the basis of site visits, experts have concluded that untracking brings no guarantee of high-quality instruction for everyone but may instead lead all to a common level of educational mediocrity."

Multiple intelligence theory is only the latest rationale for acting as if most children don't differ much in learning ability. An older approach, still widely embraced, is to accept IQ as a concept but act as if differences in IQ don't make much difference in the classroom. Education textbooks and journals in this vein speak only of "exceptional" versus "regular" students. So-called regular students are those who score between the upper threshold for mental retardation (IQ 70) and the lower threshold for giftedness (IQ 130). That continuum includes 95 percent of students. A closer look at differences in intellectual functioning across the 60-point range illustrates how different educability actually is, even among the supposedly average.

For example, individuals with IQs between 70 and 80 (but still above the threshold for mild retardation) require instruction that is highly structured, detailed, concrete, well sequenced, omits no intermediate steps, and links to what the individuals already know. They often need one-to-one supervision and hands-on practice to learn even simple procedures. As specialists in adult education explain, the material to be learned must be stripped of all nonessentials, including theoretical principles, and require only simple inferences. Any information, written or spoken, must be presented in small pieces with clear introductions and simple vocabulary. Because people with IQs below 80 (the 10th percentile) are difficult to train, federal law bars their induction into the military.

Successively higher IQs are associated with better odds of learning readily from more demanding forms of instruction, learning more independently, and mastering increasingly abstract and multifaceted material. Individuals of average IQ (100) can master relatively large bodies of written and spoken knowledge and procedure, especially when it is presented to them in an organized manner that allows them practice and provides feedback. By IQ 120, individuals are more self-instructing and better able to develop and organize knowledge on their own. The "complete" instruction that is most helpful for low-g learners is dysfunctional for these high-g individuals. The latter easily fill in gaps in instruction on their own and benefit most from abstract, self-directed, incomplete instruction that allows them to assemble new knowledge and reassemble old knowledge in idiosyncratic ways. But such forms of instruction are dysfunctional for low-g learners, who are more likely to be confused than stimulated by its incompleteness, abstractness, and requirements for self-direction.

As any teacher will attest, many other things besides *g*-level affect children's learning—illness, incentives, peer pressure, conscientiousness, parental support, familiarity with the language of instruction, and more. For these and other reasons, high *g* does not guarantee success—or low *g* guarantee failure. There's no question, however, that higher levels of *g* constitute a constant tailwind and lower levels a persistent headwind in cognitively demanding settings such as schools. Perhaps most important, *g* level affects what students are likely to learn with a reasonable expenditure of time and effort. Textbooks on instructional strategies rightly treat time as a precious commodity to be jealously guarded and wisely spent, and they note that "slow" students often need much more of it than others to learn the same material. Instruction must therefore be more tightly focused on what is most essential for them to learn.

Although slow learners cannot be turned into fast learners, all students could learn much more than they now do. Students learn best and reap the most gratification for their efforts when instruction is targeted to their cognitive needs. Good targeting is all too rare, even in schools with ability grouping and curriculum tracking. As *Looking in Classrooms* laments, such "adaptive instruction" is regularly attacked as discriminatory because it means treating students differently. Its critics would rather give all students "access" to the "high-status" curricula and self-directed, "constructivist" learning activities that benefit bright students. But that path is far more likely to harm than to help these students, robbing them of the motivation to learn, depriving them of their full potential, and hampering their prospects in a world that increasingly requires (and rewards) well-educated people. Depriving faster learners of curricula that allow them to make the most of their abilities is likewise an injustice to them and to the society that stands to benefit from their eventual contributions. By denying the difficulties in accommodating intellectual difference, multiple intelligence theories may do little more than squander scarce learning time and significant opportunities for improvements in the quality of American schooling.

The substantial heritability of intelligence has been a source of great controversy—albeit only outside the community of researchers who study the subject. But that element of heritability provides the very hope it is often said to obliterate. While it frustrates our efforts to raise IQ, it also greatly limits the harm that poor environments can do. Research roundly affirms what experience suggests: People with higher IQs have a remarkable ability to make their way out of even the most dire environments. This protection, along with the little-appreciated fact that the laws of genetics ensure that parents and children will tend to differ substantially in IQ, guarantees that talent will emerge from even the worst of environments, in turn ensuring considerable social mobility in any free society. It's not only the distribution of IQ that is helped by the laws of genetics. The mixture of genes from two parents creates traits in children that neither parent has. Heritability thus provides a very broad guarantee of difference and variety we would not have in a world where environment was all, a world that might leave humans free not only to create an egalitarian paradise but to forge the ultimate caste society of rich and poor.

It has always been the task of America's public schools to facilitate social mobility, and, historically, they have performed the job well. They should now turn their attention to optimizing the development of *all* children. For that to happen, we'll have to acknowledge that God or nature did not make us all equal intellectually. By embracing rather than rejecting the scientific knowledge about *g*, educators can develop curricula and classroom techniques that well serve the nation's cognitively diverse students. ❑