The Education Challenge: Preparing Students for a Changing World

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Introduction

The skills individuals need for success in the 21st century are vastly different from those needed in the past. Our education system must evolve in order to prepare students for the changing world in which they will live and work. American society is undergoing fundamental structural changes at the family, workplace, and community levels. These changes are being pushed by four mega-trends:

1. New and emerging technologies
2. Globalization
3. Changing demographics
4. New generations in our classrooms

As we experience these societal changes, there is a growing drum beat from the media and the political arena about the failure of American schools. Yet a careful analysis of the American educational system's status will show that, in fact, our schools are not failing; rather, schools have been unable to keep up with the rate of change in society.

Today, in American schools, we find that:

- We have a more diverse student population in our schools than ever before
- On average, we have the lowest dropout rates in the country's history
- The standards movement has exploded the number of topics or benchmarks teachers must teach
- We are now testing nearly all grades and disciplines

This is not a failing system; this is a system that is working hard to improve. Nonetheless, and unfortunately, while the system is getting better, our students are actually worse off. This is not because schools failed, but because society demands a higher and different set of skills than schools were ever designed to teach.

Internationally, the United States does not have the highest educational standards. However, we have the deepest commitment to equity. For balance of equity and excellence, the International Center for Leadership in Education has found no system that matches America's public education system.

Unfortunately, equity and excellence are in conflict. Schools can achieve excellence quickly if they do not address equity issues. If we could pick and choose whom to educate, we obviously could attain higher standards faster; but that is not the American way. Equally as important to the commitment to equity is the recognition that equity costs money. Yet without excellence by international standards, America will find it increasingly difficult to provide equitable opportunities for individuals in poverty, the aged, the disabled and members of all ethnic groups.

Through a major effort, the International Center, in partnership with the Council of Chief State School Officers (CCSSO) and with financial support from the Bill & Melinda Gates Foundation, has spent the past year searching the country for examples of highly successful schools, especially at the high school level. Through this process, the International Center has uncovered some extraordinary success stories. Unfortunately, many of these stories represent random acts of accomplishment and are not systemic in the nation's schools. We need to learn from these highly successful schools and incorporate their most successful practices into schools throughout the nation.

Essential to schools' success is absolute commitment to a rigorous and relevant curriculum for *all* students. This paper describes the many challenges facing American education today and discusses how

highly successful schools have created the culture that permits fundamental change to enable all students to achieve rigorous and relevant curricula. It also presents the specific strategies that successful schools have undertaken in their implementation of rigorous and relevant curricula.

Mega Trend #1 – New and Emerging Technologies

Information technology is progressing so rapidly that one must go back as far as the Industrial Revolution – two centuries ago – to gain proper perspective. Reviewing the major technological inventions and breakthroughs that have occurred within the last 15 years, one wonders whether the pace could be maintained for the next 15. If anything, the rate of innovation is likely to accelerate over time. In 1991, who could have imagined – other than those in research and development – the impact that the Internet, e-mail, cell phones, PDAs, and BlackBerries would have on the way people conduct their everyday personal and professional activities? In 2006, can we truly fathom the societal impacts that wireless sensor networks, grid computing, DNA computers, nanotechnology, molecular imaging, mechatronics and biomechatronics, language translation software, and other emerging technologies will have on the global economy during the next 15 years?

When it comes to technology, it is easy for older generations to be awed by younger people's savvy. Technology changes so dramatically in such a short period of time that those who do not use it regularly risk becoming obsolete. For many who did not grow up using computers and other "intelligent" technologies, the introduction of these products was initially met with skepticism. Now, most people can scarcely imagine life without them. Of course, most would agree that once you become acclimated to technology, further advances are not quite as daunting because some skills already are in place. Still, today's students, who have grown up in the modern age of information technology, have a great advantage because their learning curve is less steep than that of older generations. The current generation of students is "native" to technology, and their interests revolve around it because they grew up immersed in a technological world.

Interestingly, in the United States, students appear to be learning the majority of technology skills in extracurricular settings rather than through formal schooling. Certainly, students continue to get the requisite rigor of core subject matter in schools, but the skills they need to compete in the information age – relevant 21st century skills such as critical thinking, problem solving, and effective communication – are acquired outside of the classroom. Through technology, millions of students from developing countries around the world now have the ability to develop this skill set, essentially leveling the proverbial global playing field. American high school graduates can no longer boast of an unparalleled education as theirs is not even near the top, as evidenced by comparative international assessments.

In the 21st century, science and engineering will become the cornerstones of what one must know and be able to do, but the United States is being outpaced dramatically by India, China, and Eastern European nations. The decline of American enrollment in science and engineering fields concurrent with the increasing demand for professionals in these fields, places the United States at a great disadvantage in the global marketplace. Continuation of these trends could result in severe human and economic consequences for this nation. Following are some emerging technologies that will help shape our future world.

Motes and Wireless Sensor Networks

A computer's worth is not always judged by its computing power. A mote, also known as "smart dust," is a small, low-cost, low-power sensor. Each mote is about the size of its power source – in some cases a set of AA batteries – and comprises a processor, a small amount of virtual memory, and sensors to monitor environmental variables such as light, humidity, pressure, and temperature. Motes can be linked to form a wireless data collection network because each is equipped with a radio transceiver that is just powerful enough to broadcast snippets of data to other nearby motes. Ultimately, the data are transmitted to a server to create a database from the many pieces of information collected.

Motes have the potential to monitor many aspects of our daily lives – the environment, machines we use, our own or others' body functions – easily and inexpensively. As mote technologies advance, motes will continue to shrink in size, and, as they will require less power consumption, could conceivably run on solar or even vibration power. David Culler, a computer scientist at the University of California at Berkeley, has been working with motes for the past seven years, as reported by Wade Roush in the February 2003 issue of *Technology Review*. "It's one of the big opportunities" in information technology, says Culler. "Low-power wireless sensor networks are spearheading what the future of computing is going to look like."

In Maine, a wireless motes network was used to conduct research to better understand the environmental threats to the endangered Leach's Storm Petrel, a bird species found on Great Duck Island. This study, conducted by the College of the Atlantic and the University of California at Berkley, used a remote wireless sensor network made up of 32 motes distributed throughout the island, which provided unobtrusive monitoring of this sensitive environment. A wealth of atmospheric data was collected that could be used to help better understand the environmental needs of this species.

Enviromatics

Enviromatics – a term derived from the words environment and informatics – is an emerging technology that uses the real-time data gathering ability of remote wireless networks, the data sharing ability of the Web, and greater computing power to make more informed decisions about various environments. Enviromatics relies heavily on three technologies: (1) motes and wireless sensor networks; (2) new Internet formatting standards, such as Extensible Markup Language, which form a Semantic Web; and (3) grid computing. When combined, these technologies offer the capacity to accurately collect large amounts of data, comparatively analyze it, and make short- and long-term predictions based on the analyses.

Current research illustrates how enviromatics can be practically applied to situations ranging from the most effective time for farmers to apply herbicides to their crops to minimizing human impacts on environmentally sensitive areas. Researchers at Pennsylvania State University's Center for Environmental Informatics explain how a farmer in Pennsylvania could find environmental data gathered from other wheat-growing states, including the likelihood of the fungus *Fusarium* spreading to his farm. Based on the data, a specialized Web site would provide local maps with risk-levels, which would allow the farmer to determine if and when to apply fungicides to stop the disease from devastating his wheat crops.

Decision making is always strengthened when all available data – either from a larger sample or from many areas – can be considered. The Internet gives us access to a wealth of information, but unfortunately, not all information is easily accessible in the Web language that we commonly use now, Hypertext Markup Language (HTML). A new language has been developed, Extensible Markup Language (XML), which allows for easier sharing of data and documents thereby allowing broader access to scientific data. This, however, is only the beginning. The next step in data sharing will be the Semantic Web. XML begins that process by putting data in a form that machines, in this case computers, can

understand. A search engine on the Semantic Web will be able to apply logic to a query, ultimately delivering an information-rich, relational data set that targets a specific inquiry.

A current European research initiative is examining cervical cancer, which claims 30,000 lives across Europe alone each year. The main objective of Association Studies Assisted by Inference and Semantic Technologies (ASSIST) is to facilitate cervical cancer research "through a system that will virtually unify multiple patient record repositories physically located in different medical centers/hospitals." Imagine the research knowledge and power of the ability to easily access the health and medical records of every woman who had cervical cancer. ASSIST is hoping to do just that in Europe, using the Semantic Web to uncover relationships between patient habits, patient genotype, and the disease.

The final piece of emerging technology that will help bring enviromatics to scale is grid computing. Essentially, grid computing enables raw data collected using wireless sensor networks to be extracted, preferably from the Semantic Web, and analyzed quickly via parallel processing. Grid computing has the clear ability to significantly accelerate data analysis capacity: in 2003, scientists used grid computing to identify 44 potential treatments for the deadly smallpox virus. Because of the grid, the research took only three months to complete, as opposed to more than a year.

Grid Computing

As referenced above, grid computing involves linking computers to create a large system with massive computational power. Grids are able to take a large data set and break it down into many smaller pieces that can be processed simultaneously. While a single computer processes data sequentially, grid computers process data in parallel, dramatically increasing efficiency.

Grid computing is already changing the way scientists use data. In 2003, scientists completed a draft sequence of the Human Genome, a tremendous milestone in science. Yet, in order to research disease treatments and cures, scientists must identify the functions of the 30,000 proteins that are encoded in the Human Genome; right now, the structure and function of only a fraction of these proteins is understood.

In 2004, the World Community Grid (www.worldcommunitygrid.org) was launched to harness unused computer power from millions of idle PCs to provide the computing resources needed to accelerate research into diseases such as cancer, HIV/AIDS, and Alzheimer's. That same year, the Human Proteome Folding Project, the quest to uncover the secrets of the remaining Human Genome proteins, signed on to the World Community Grid. The use of the grid could shrink to months – instead of the years supercomputers would require – the time necessary to analyze the massive amounts of data that have been gathered about the individual proteins of the Human Genome.

DNA Computers

DNA holds the potential to perform calculations many times faster and hold billions of times more data than silicon microchips. One pound of DNA has the capacity to store more information than all the electronic computers ever built. The computing capability of a teardrop-sized computer using DNA logic gates will far exceed that of the world's most powerful supercomputer. More than 10 trillion DNA molecules can fit into an area no larger than one cubic centimeter. With this small amount of DNA, a computer would be able to hold 10 million megabytes of data and perform 10 trillion calculations at a time. The more DNA is added, the more calculations could be performed. What makes DNA computing so much faster than the traditional, silicon microprocessor is its ability – as in grid computing – to do parallel computing.

Scientists at the Weizmann Institute of Science in Israel have developed a computer made of a liquid solution of DNA and enzymes that can diagnose disease and dispense medicine to treat it, as reported in the April 29, 2004, edition of *The New York Times*. The computer is about one-trillionth the size of a drop of water. "Eventually we have this vision of a doctor in a cell," said Dr. Ehud Shapiro, who led the Weizmann Institute's development team. The "doctor-in-a-cell" DNA computer still resides in a test tube, and it could be decades before it is ready for public use, but it offers an intriguing glimpse into the future of medicine and the creative ways in which technology will be used.

Nanotechnology and Nanobiotechnology

It sometimes takes years before a patient's condition or disease is diagnosed. Doctors can run batteries of tests, take x-rays and the like, and still not know what caused painful sleepless nights, numbing sensations in the face, chronic back pain, or ringing in the ears. Through advances in nanotechnology and nanobiotechnology, however, identifying the causes of bothersome or life-threatening diseases may someday rely on components that are a fraction of the width of a human hair.

E-Nose, a product of the California-based company, Nanomix, uses minute, highly sensitive carbon tubes to analyze the residue left by a person's breath, in essence simulating the human olfactory system in identifying disease-causing molecules. The sensors can scan for simple or complex bacteria. Currently, the device is able to detect rotten food, toxic chemical agents, and the difference between cigarette smoke and smoke from fire. Developers hope that someday, a version of E-Nose or a similar device will be able to detect, treat, or even cure a multitude of diseases.

The use of nanotechnology and nanobiotechnology already is has changed dramatically treatment of some diseases, including diabetes mellitus, a serious metabolic disorder that affects the body's ability to regulate blood sugar levels.

Over the past several decades, the prevalence of diabetes has increased dramatically, much of which is attributed to factors such as increasingly sedentary lifestyles and the rising global population of people over age 65. The World Health Organization estimates that by 2025, there will be more people with diabetes in the world than the entire population of the United States. In the United States alone, an estimated 21 million children and adults, or 7 percent of the population, have the disease, though only an estimated 14.6 million have been diagnosed. With statistics such as these, it is easy to understand why the development and availability of cost-efficient and effective treatment is critical on a global scale.

There are two forms of diabetes. Type I diabetes, once known as insulin-dependent diabetes, is diagnosed in childhood through early adulthood. It results when the pancreas produces little or no insulin, the hormone responsible for regulating blood sugar. This form of the disease is managed through insulin injections. Type II diabetes accounts for more than 90 percent of cases worldwide and was once called non-insulin-dependent diabetes. Historically, it has been diagnosed in middle to late adulthood, but increasingly, it is diagnosed in younger adults and even in children, the result of increases in rates of obesity. Type II diabetes results when the body develops a resistance to insulin. When the body is unable to use the insulin correctly, blood sugar levels fluctuate dramatically. Two-thirds of type II diabetes cases are treated by regulating blood sugar levels through diet or medication; the remaining one-third of sufferers, like type I diabetics, require the use of insulin. If untreated, either form of the disease can cause myriad complications or death. Nanotechnology and nanobiotechnology have helped provide insulin-dependent patients with a range of treatment options.

The discovery of insulin in 1922 showed that diabetes is a treatable disease. More than 50 years later, in the late 1970s, insulin pumps were introduced, offering the ability to deliver rapid- or short-acting insulin 24 hours a day through a catheter placed under the skin. Since then, pumps have become dramatically

smaller, easier and safer to use, and more durable; today's pumps are about the size of a beeper. More recently, implantable Microchips with tiny reservoirs that can store and release medications as needed have been developed and may eventually replace insulin pumps and injections.

Diabetics who use battery-operated pumps may someday find their devices are powered by tiny nanowires. Researchers are now easily making these inexpensive components to harvest mechanical energy. Just by walking, a person generates 67 watts of power, and researchers have been able to convert 17 percent to 30 percent of that into electricity. Researchers at Georgia Institute of Technology currently are trying to harness this energy by implanting nanowires into shoes so that people can generate electricity when walking. This technology could power small devices such as cell phones, beepers, and insulin pumps and also may provide insight into how to eventually develop medical implants that use electricity generated from pulsing blood vessels.

Alternatives to insulin-based treatments, pancreas transplants and islet transplants from deceased donors, also have been successful because of nanotechnology. Using ultrasound technology, doctors perform islet transplants – called the Edmonton Protocol – by using a small catheter to inject cells directly into the liver. This allows non-functioning cells to be replaced; unfortunately, demand for these cells significantly outweighs supplies. Through nanobiotechnology, researchers and doctors have been working diligently to find new methods of combining and creating medicines and treatments methods to address such issues. Two advances show particular promise.

In January 2005, doctors successfully performed a living donor transplant in Japan: a healthy, 56-year-old woman gave her 27-year-old diabetic daughter insulin producing islet cells.

The second potential option for islet transplantation raises ethical and moral questions. Researchers at the University of Minnesota's Diabetes Institute for Immunology and Transplantation have successfully reversed diabetes in monkeys using transplanted islet cells from pigs. If this research continues to show potential, efforts will move forward to develop and operate bio-secure barrier facilities to raise high-health pigs for pig islet transplant trials in humans. In fact, with advancements in DNA technology, pigs are now being genetically manipulated to carry human genes, which increases the potential of xenotransplantation (animal-to-human transplant). Until recently, xenotransplantation had failed, but now is considered to be a potential cure for – not just a treatment to manage – diabetes.

Yet another treatment for diabetes, courtesy of nanobiotechnology, may reach pharmacy shelves sometime this year. California's Nektar Therpeutics has created insulin particles small enough to be inhaled and absorbed through the lungs. This oral-inhaler system has been tested on 3,000 patients and could replace the fast-acting insulin shots some diabetics need to have before meals.

Molecular Imaging

The use of magnetic resonance imaging (MRI) is revolutionizing neurological science. Most relevant to this discussion is neuroscience's shifting focus from mapping the brain to identifying factors that influence the brain's ability to learn.

MRI allows scientists to follow living, growing brains in the same individual over a period of time, gaining insight into how the human brain develops from childhood through adolescence and into adulthood. Because MRI does not use radiation, the technique is safe and efficient, and it has given scientists the tools and resources to investigate more fully the relationship between what is happening neurologically and what we observe and experience behaviorally.

In March 2006, using data gleaned through molecular imaging, researchers at the National Institute of Mental Health (NIMH) discovered that children with superior IQ scores are distinguished by how fast their prefrontal cortex thickens and thins as they age. This strongly suggests that highly intelligent children experience an extended critical period of development. According to Paul M. Thompson, a brain imaging expert at the University of California at Los Angeles (UCLA), this was the first study that showed that physically, the brain develops differently in highly intelligent people.

Gray matter is the brain's nerve cells (neurons) and tiny branchlike tributaries known as dendrites. From infancy through early childhood, brain activity and growth occurs at the highest levels. Using MRI and other techniques and technology, scientists at NIMH, the Brain Research Institute at UCLA, and Harvard University's McLean Hospital have discovered that the brain experiences a second wave of proliferation and pruning of gray matter that begins in the pre-puberty years, and extends into adulthood. Between the ages of 6 and 12, children experience a massive build-up of gray matter, which typically peaks in males at age 12 and in females at age 11. This allows children to develop enormous brain capacity to be skilled in many areas, and this is the time when children move from being highly skilled dependant learners to novice independent thinkers.

The use of molecular imaging also reveals that the proliferation of gray matter is followed by a pruning period that lasts for several years. During this stage, white matter – composed of fatty myelin sheaths – thickens and encases the axons of the brain cells making nerve transmission faster and more efficient. Pruning, also known as the "use-it-or-lose-it" phase, is critical to the developing adolescent brain. Neurons that are frequently stimulated will make connections with other neurons, allowing for growth; idle neurons wither and die. Nobel prizewinning neuroscientist Gerald Edelman has described this process as "Neural Darwinism." Once the first connection is made, subsequent transmissions become faster and more efficient, resulting in greater long-term memory.

This development takes place primarily in the frontal lobes, specifically in the prefrontal cortex, the area right behind the forehead. This region is like the CEO of the brain, performing executive functions such as sound decision-making; goal-setting; planning and organizational strategies; multi-tasking; and control of impulses and emotions. Research indicates that this region is not fully developed until early adulthood. Unfortunately, students in middle grades are put in situations daily where they are expected to demonstrate adult-like organizational and decision-making skills, even though they are not biologically prepared to do so. This stage also is a time of enormous risk and opportunity for young adults as they begin to focus on what makes them unique, to identify their strengths, and to specialize in their thought processes.

Another area of the brain that is of particular significance in early adolescent development is the amygdala. This almond-shaped structure is integral to the processing of emotions and controls both fear and pleasure responses. Emotional responses and irrational behavior – characteristics of the middle-grades learner – have long been blamed on "raging" hormones, but the availability of MRI and functional magnetic resonance imaging (fMRI) have added brain development to the mix. MRI has shown that hormones released from the adrenal gland work their way to amygdala, causing it to flare up. This results in frequent emotional outbursts and also leads adolescents to pursue exciting or thrilling experiences. A recent study using fMRI compared brain activity in adults and teenagers when they were presented with pictures depicting human emotions. Adults correctly identified emotions nearly 100 percent of the time, primarily using the prefrontal cortex when making decisions. Teenagers responded correctly only about 50 percent of the time, indicating that they rely more heavily on the amygdala when making their choices. This suggests that the emotional center of the teen brain holds control over the more rational prefrontal cortex. This could explain why adolescents have difficulty reading facial expressions or social signals and why their responses tend to be more emotional than executive, thoughtful, or measured.

Mechatronics

Mechatronics integrates aspects of mechanical engineering, electronic systems, control systems, and intelligent software in the design processes used in a number of industries. Mechatronic system designs aim to be simple, economical, reliable, and versatile. Major industries such as automotive, aerospace, medical, defense systems, manufacturing, and consumer products all are employing mechatronic systems designs.

The automotive industry incorporates many mechatronic systems into newer automobile designs and is an excellent example of mechatronic design in action. With traditional mechanical systems, often a driver is not aware of a system fault until failure occurs. But electronic devices and software can monitor the condition of car components at all times, alerting a driver if there is a fault in the system even before the fault leads to failure. To improve everything from fuel economy to car safety and performance, automotive researchers are combining many familiar mechanical auto systems with new electronic components and intelligent-software control. In the February 2003 issue of *Technology Review*, writer David Talbot discusses the practical application of this hybrid approach for anti-lock brake systems. He describes how, in the next five to 10 years, electromechanical actuators will replace hydraulic cylinders; wires will replace brake fluid lines; and software will mediate between the driver's foot and the action that slows the car.

The 12th Annual World Congress on Intelligent Transport Systems, an automotive industry conference held in San Francisco in November 2005, showcased some of the newest technologies – resulting from mechatronic design – that may appear in cars in the near future. Toyota demonstrated its "Intelligent Parking Assist" technology, which currently is available in Japan and Europe and which will likely become available in the United States within the year. Toyota engineer Masato Okuda, who demonstrated the Intelligent Parking Assist feature at the conference, explained to *Wired News* that "the idea [behind this feature] is to reduce the driver's workload." Using Intelligent Parking Assist, a driver essentially allows the car to parallel park itself and uses only the brake pedal to control speed during the maneuver.

Cars in the future might also provide drivers with real-time information about traffic jams, traffic light cycles, and available parking spaces. Engineers are developing technology that will allow vehicles in close proximity to communicate with one another. This technology is still a few years away, but in theory, cars equipped with wireless transponders will be able to broadcast information such as speed and braking status to nearby cars with similar transponders, helping to ensure greater safety on the road. As Intelligent Transport Society of America CEO Neil Schuster told *Red Herring* in November 2005, "Our vision is zero fatalities and zero delays."

Many other well-known consumer products and appliances incorporate a hybrid system design in which traditional mechanical components are merged with mechatronic features so products function better. Equipment such as auto-focus cameras, video cameras, CD and DVD players, and washing machines, to name a few, all benefit from mechatronic systems.

Biomechatronics

Biomechatronics, an emergent offshoot of mechatronics, refers to the science of integrating mechanical or robotic systems with the human body. Like those who consider a career in mechatronics, those interested in biomechatronic must develop a multidisciplinary "tool kit" for their work, adding to their résumés coursework in biochemistry and related fields.

Therapeutic biomechatronic devices signify a new generation of prosthetics that work similarly to real limbs. Hugh Herr, head of the Biomechatronics Group at the Massachusetts Institute of Technology's

(MIT) Media Laboratory, is a leading developer of new technologies for amputees. A double leg amputee himself, he is credited for developing the Rheo Knee™, which recently has been commercialized by the Icelandic company, Ossur. Because Rheo Knee™ is not wired into a user's nervous system, it is not a true biomechatronic device; nonetheless, this "intelligent" prosthetic knee system automatically adapts to an individual's walking style and environment. On its Web site, Ossur describes how the device works: Integrated sensors feed information to a microprocessor that "teaches" the knee how the user walks by recognizing and responding immediately to changes in speed, load, and terrain. The sensors are able to measure how far the knee is bent, as well as the amount of force the wearer applies to it while walking. The microprocessor analyzes the sensor data to create a model of the wearer's gait, adapt to the movement, and apply the correct amount of resistance given the conditions.

Herr's work in biomechatronics, described in the May 2005 edition of *Technology Review*, is inspiring the next generation of artificial limbs in which sensors are distributed beyond the knee joint. This enables the prosthetics not only to detect mechanical forces of the body – as the Rheo Knee™ does – but neural signals from muscles near the knee joint as well. Herr predicts that within seven years, spinal-cord injury patients, at least in research settings, will move their limbs again by controlling robotic exoskeletons to which they are attached.

Herr also is working on a biomechatronic prosthetic ankle prototype, for which he plans to be the first test subject. Three small sensors will be implanted in the muscles of one of his legs, below the knee. As the muscles are flexed in the manner that once moved his ankle, the sensors will measure the muscles' electrical impulses and relay the information to a computer chip in the prosthetic ankle. The chip will translate the information into response instructions for the ankle's motors. "I think it will be quite profound to control my ankles again," says Herr. He envisions the field of biomechatronics one day merging with tissue engineering so that prosthetic limbs would be hybrid devices comprising both artificial materials and human tissue.

Language Translation Technology

If any one technology is indicative of how rapidly the boundaries of culture are shrinking across the globe, it is one that makes it possible to speak in one language and be understood in another. Language translation technology, which has been under development for at least 20 years, has only recently produced promising results. Accurate machine translation software is very difficult to develop and existing translation software systems that allow for translation of spontaneous speech are limited to such scenarios as making hotel reservations.

Researchers at Carnegie Mellon University (CMU) in Pittsburgh are making momentous progress in advanced communication technologies so that, in as little as 10 years, technology may finally bridge the language divide between countries and cultures. During a demonstration at CMU, reported in the *Pittsburgh Tribune-Review* on October 28, 2005, a researcher stood before an audience with 11 tiny electrode sensors attached to the muscles of his cheeks, neck, and throat. He proceeded to mouth – without speaking aloud – in Mandarin Chinese the phrase "Let me introduce our new prototype." The sensors captured the electrical signals from the speaker's facial muscles and relayed them to a computer. Not only did the computer recognize the words, but it translated them into both English and Spanish, displayed the phrase on the computer screen, and "spoke" the phrase in both languages. CMU researches believe that even further into the future, electrodes could be implanted into a person's mouth and throat, essentially creating instant bilingualism.

Alex Waibel, a computer science professor at CMU and director of the research, also demonstrated "translation goggles." These high-tech eyeglasses display translated text on a miniature virtual screen that

only the wearer can see. Waibel's speech was translated from spoken English into Spanish text, similar to how movie subtitles appear at the bottom of a television or movie screen.

The biggest challenge in developing accurate, advanced communication technologies of this type continues to be translation of spontaneous speech rather than scripted phrases. Waibel and his team are developing statistical methods that enable the technology to learn from the abundant sample translations available on the Internet.

Typewriter Keyboard Technology

Despite the vast technological advances described above, one key component of many of these technologies has been largely, and curiously, overlooked: keyboards. Most computer keyboards today reflect pre-computer functionalities, designs, and engineering. Even the layout of the keys has changed little since the keyboard was first patented around the time of the Civil War. The standard QWERTY configuration, so named for the letters in the upper left hand row, was adopted to minimize key jams in manual typewriters, a problem that plagued fast typists especially. Although computers have rendered the QWERTY layout obsolete, typists are so accustomed to it that newer, more efficient layouts have never really been accepted.

A company called TypeMatrix is working to apply advances in technology to this relatively low-tech but essential tool. The company has developed a keyboard that is computer-friendly, user-friendly, ergonomic, and versatile. It can accommodate any foreign language, PC or Mac platforms, and laptop or desktop computers; it also is very portable. The standard layout has been modified so common computing functions have easy-to-reach, mid-keyboard key placements, and additional keys, for functions such as "cut" and "paste," have been added and placed for efficient use. Despite the many changes, the configuration is still based on the QWERTY design, although it also can be adapted to other layouts.

Mega Trend #2 – Globalization

September 11, 2001, is a date Americans will never forget. The vision and memory of planes crashing into the World Trade Center, the Pentagon, and the field near Shanksville, Pennsylvania, have changed the way we view ourselves and the world around us. November 9, 1989, though not immediately recognizable as the date of another significant global event, is the date the Berlin Wall came down, symbolizing the fall of communism in Eastern Europe. Since then, the Eastern Bloc nations of the former Soviet Union have entered the free enterprise system. And although India gained its independence from Great Britain in 1947, it was not until the late 1990s that the socialist-leaning government was replaced by one deeply committed to a free enterprise system. More recently, China, one of the few remaining communist nations in the world, has emerged as a powerful participant in the global economic arena.

From the Eastern European nations and Russia to India and China, we have witnessed the rapid spread of capitalism to more than half of the world's population in just 17 years. These nations saw the potential of what the free enterprise system can provide, in particular, a prosperous middle class. A century ago, the United States understood the challenge and enormous effort required to become a prosperous nation during a significant time of transition. Similarly, the Indians, Chinese, and Eastern Europeans recognize the energy and sacrifices required of them as individuals and realize the benefits of restructuring their countries from industry-based to information-based societies. Current trends suggest that these nations are very willing to put forth the effort needed to attain a middle-class standard of living for their citizens. Americans, in general, and our youth, in particular, seem to believe it is their birthright to enjoy a middle-class lifestyle and carry a false sense of security and comfort. As a result, however, we lack the drive needed to match the aggressiveness of other nations in the global economy.

Americans have consistently stood behind the notion that the United States is the premier superpower in the world. We do indeed have among the best – if not the absolute best – healthcare, highway, and educational systems compared to other countries. Yet, a common fear amongst scholars and economists is that Americans have been lulled to sleep by Asian and Eastern European nations with regard to the validity of our status as a superpower in the 21st century. The challenges facing many of our systems and structures, with the rise of the global economy, have significant implications for future generations. While many believe that the United States has calmly faced the rise of a global market, it has become quite clear that we have awoken two sleeping giants – India and China – which are producing more scientists and engineers each year than any other countries in the world. Not only must we be aware of the competitive edge India and China are developing, but we must also be cognizant of the changing demographics of the world as a whole.

When we consider the current and future status of the global economy, we must make a strong effort to understand the various dynamics that comprise a "flat" world and their significant implications for economic growth in the United States. Since 2001, the global economy has been rather resilient. The United States has remained the leader, emphasized by the value of the U.S. dollar, which has continued to lead global currency. In 2005, the value of the dollar increased by 12 percent on the Euro and 7 percent on the Yen. The G8 produces 80 percent of the world's economic output, and economic growth has been fueled by increases in people and spending. More people are moving and will move in the future, causing many nations to become either exporters or importers of people; this is at the core of new immigration policies and debates in the United States, United Kingdom, Singapore, Australia, and other nations. In addition, economic and social trends reveal:

- Continued growth of a knowledge-based global society due to the growth of the information industries
- Dramatic growth of the elderly population
- Shifts in the world's population due to mass migration
- Domination of economies and societies by technology
- Continually increasing oil consumption, despite the demand for alternative energy sources

These economic and societal trends have enormous implications for all nations, especially as they relate to competition in the future global market. Our world has become a place in which trade and competition are no longer the dominion of one or two superpowers. An increasing number of competitive markets have emerged in the past 20 years, including India and China. We must realize that the future is now, and face the possibility that perhaps the United States has been too complacent. "We are no longer a big fish in a small pond," says Navi Radjou, an analyst for Forrester Research. "We are a medium-size fish in a big pond, and some of the other fish are sharks."

The Rise of India

Based on his linear stages of economic growth, economic historian W.W. Rostow's has concluded that India reached "the interval when the old blocks of resistances to steady growth are finally overcome" in 1952. Rostow called this interval the takeoff, and calculated that India would reach its maturity – the state in which technological and entrepreneurial skills would offer that nation the ability to produce anything of its choosing – after about 20 years, as reported by Ayres and Oldenburg in 2005 for the Asia Society. This change, however, did not occur in 1972 as predicted. As recently as 1991, India was in dire financial straits. The newly elected finance minister decided that the only way to save the country from economic ruin was to abolish existing trade controls. Economic liberalization opened India's doors to foreign investors and eradicated much of the bureaucratic red tape that had impeded business growth.

Now, an additional 35 years later, the predicted change is finally underway. India has become one of the fastest growing economies in the world, boasting a population of 1.1 billion and a gross domestic product (GDP) of $585 billion, double what it was just two years ago. More than half of India's GDP is no longer agricultural, but is based on industrial growth and the services sector. What has become even more impressive is the fact that, at 8.3 percent, India's GDP growth ranks second in the world and is expected to increase by 8 percent to 10 percent annually during the next 10 years. India's knowledge-based industries have become global models of excellence.

As a result of these changing demographics, India now ranks among countries whose largest proportion of the population is of working age. Foreign exchange reserves are at an all-time high: in March 1998, foreign exchange reserves were less than $30 billion, but by the end of July 2004, reserves were at $118 billion. In January 2004, President George W. Bush announced the "Next Steps in the Strategic Partnership" between India and the United States, which includes an agreement to expand cooperation in three areas:

1. Civilian nuclear activities
2. Civilian space programs
3. High-technology trade

The "Next Steps" agreement indicates that the economic relationship between India and the United States is expected not only to continue, but to prosper and to grow exponentially in the future, implying that India is well on its way to establishing itself as powerful force in the global market.

In addition to its effects in the political, financial, and social sectors, India also is playing an increasingly important role in information technology innovation. Motorola, Hewlett-Packard, Cisco Systems, and other technology giants rely on their Indian employees to design software platforms and futuristic multimedia features for next-generation devices, as reported in the August 22/29, 2005, edition of *Business Week*. In December 2005, Microsoft announced that it plans to invest $1.7 billion in India and nearly double its work force there by adding 3,000 jobs over the next four years. Microsoft co-founder and Chairman Bill Gates said a substantial portion of the investment will go toward designing an operating system in nine native languages specifically for India. The new investment follows $400 million that Microsoft announced in 2002. Intel Corporation will invest more than $1 billion in Indian technology companies over the next five years. Cisco Systems Inc. plans to spend $1.1 billion in India over the next three years.

Nonetheless, India still lags dramatically behind the United States in terms of the equity and excellence in the infrastructure and system of education. Of every 100 children who begin school, only 52 will reach the fifth grade. Only 85 out of 100 children have the opportunity to attend public schools. This trend is hardly surprising in a nation where 63 percent of births are not registered, 25 percent of babies are not immunized and 16 percent of babies have no access to clean drinking water.

Despite the infrastructural obstacles facing the country, government officials have committed themselves to policy reforms that will improve the quality of education offered to all students in the immediate future. A newfound belief in educating every child has become a mantra, and there have been strong efforts to establish a higher education system that embraces the potential to serve the nation's academically best and brightest. India's seven Institutes of Technology, Science, and Mathematics have become the premiere institutions of higher education.

On average, the institutes receive more than 400,000 applicants each year for only 4,000 places. This highly competitive admissions process motivates and encourages students. The decision to invest in the

nation's most intelligent students has enabled India to position itself favorably in the world economy, which, in turn, has propelled the country to the status of a leader in the areas of science, mathematics, and technology. India's devotion and investment will secure its place as a major player in the world market and a competitor to watch.

The Rise of China

"To get rich is glorious," declared China's leader in 1977, signifying the opening of the world's most populous country to international trade. In China today, there is no question that communist ideology takes a backseat to capitalism in terms of economic growth. China's ascension as an economic empire dwarfs that of the United States during its own rise to power. For the past two decades, China's average annual economic growth has been at an incredible rate of 9.5 percent. If this continues, China's economy could be 75 percent larger than that of the United Status by 2050.

China's population is about 1.5 billion and is projected to increase by 60 million people by 2012. In 2005, China had between 100 and 160 cities with populations of one million people or more. In contrast, Europe has 36 and the United States, just nine. Along with opening its economy to free enterprise, the Chinese government made another radical concession: allowing peasants to leave the countryside to search for opportunities in urban areas. Hundreds of millions of farmers and peasants – more than the total workforce population of the United States – have migrated to coastal cities hoping to make better lives for themselves. By 2020, China is expected to have 1.1 billion workers, which will require the creation of 10 million jobs annually to be sustained.

Whether or not we realize it, China's consumers, vendors, employees, employers, and manufacturers have an impact on our lives every day. In the not-so-distant past, a product labeled "Made in China" would never have been mistaken for a German-made machine, a Japanese-made television, or an American-made cabinet or textile. This is no longer true.

In *China, Inc.*, Ted Fishman shares many eye-opening statistics. China leads the world in the number of clothes made and toys assembled. China makes more than 40 percent of all the furniture sold in the United States. He estimates that of the 50 percent to 85 percent of imported merchandise sold at Wal-Mart, the majority is made in China. Furthermore, around 2000, China became the world's largest manufacturer of consumer electronics. China now has the second largest personal computer market, the largest mobile phone market (25 percent ownership), and the third largest retail market in the world, which is growing by 10 percent annually. In addition, China is now the largest producer of coal, steel, cement, color televisions, and cell phones, according to David Arkless of *MANPOWER.*

The Chinese have become extremely focused in ensuring their success as an economic stronghold, both in the public and private sectors. Now one of the world's largest oil importers in the world, China also is one of the largest investors in oil exploration. As Thomas Friedman points out in his bestseller *The World is Flat*, in the private, non-state owned sector of Chinese industry, productivity increased 17 percent annually between 1995 and 2002. And now, with its membership in the World Trade Organization, China is powerfully poised in the global economy, a position that is only strengthened by its efforts to collaborate with other nations.

At the root of China's unquestionable success in the world market is its strong educational system. The country produces some of the world's brightest students, who, in turn, become world-class business managers, scientists, and engineers. China is still identified by many of India's educated and influential as the most likely source of insecurity to India and the greatest potential long-term threat to that country's interests. The United States may be wise to consider China in much the same manner.

Regaining the Advantage

Countries such as India and China are certainly on the fast track to competing vigorously with the United States and other countries on every economic issue and investment. The rise of these two countries and others in Eastern Europe should inspire Americans to consider what we are doing to prepare future generations for competing in the race to the top. But we must do so quickly, as the longer we wait to take action, the sooner we will find ourselves buried too deeply in the complex sands of this global pursuit.

If we are to tip the scale of the competitive balance in favor of the American worker, we must improve our educational standards and continuously revisit our vision for the future. Our education system has become extremely assessment-oriented, dedicated to evaluating students based on test performance. Yet Americans have always valued the importance of instruction and success beyond the test. Countries throughout the world that have typically assessed students based solely on intelligence levels are now looking to the United States for assistance with evaluating and instructing students based on their abilities to use knowledge in real-world situations. In shaping our vision for the future, we must ask ourselves: "Are we letting go of our advantage?"

The challenges facing the United States in this pursuit are numerous. If we truly value children as our greatest national resource, we must invest in their future. The United States may not have the massive human resource numbers as China or India, but education can be the great equalizer. The United States has proven that it could invest in education in the past; and that investment led us to become the most powerful nation on Earth. We must summon the will to do so again. This means providing better classrooms in *all* regions of the country, raising educational standards to reflect the relevancy of the times, and restoring a sense of national pride in our education system.

Mega Trend #3 – Changing Demographics

Demographics and the U.S. Economy

By 2008, the oldest of the baby-boom generation will be 62 years old, marking the first wave of early retirees from the largest generation in United States history. With so many workers phasing out of the labor force and not enough new talent entering, many of the nation's leading financial experts see dark days ahead for the American economy. The fast-rising costs of healthcare benefits for retirees, coupled with the strain that baby boomers will place on the Social Security system and the high cost of many existing pension plans, have budget watchdogs warning of severe fiscal trouble. In fact, terms such as "fiscal hurricane" and "death spiral" have been used to underscore just how serious the situation is. David Walker, comptroller general of the United States, was quoted in *USA TODAY* November 25, 2005, as saying, "We face a demographic tsunami [that will] never recede."

The Pension Problem

Nearly all areas of the labor market – in both the public and private sectors – are starting to feel the strain on their fiscal budgets. Some have been struggling to meet obligations to their workers for a few years already. Many pension contracts are criticized as being too expensive and for unfairly punishing younger taxpayers who will never be offered similar benefits at their own retirements. Here are just some public pension plans that are in serious financial straits, according to an *Associated Press* article printed December 29, 2005:

- Colorado's state and school employees plan had just 70 percent of the money needed to cover its pension obligations in the 2004 fiscal year

- Missouri's plan for transportation and highway patrol employees had only 53.4 percent of the money promised to it
- The Illinois State Employees Retirement System was funded at 54.2 percent

Teacher pension plans are in the crosshairs of many state and local officials. Teachers in Illinois were among the first to see their retirement benefits come under attack. The state has promised $51 billion in pensions to 225,000 current and retired teachers, but has only $31 billion in its accounts to meet those obligations. With a $20 billion deficit, the Illinois teacher pension fund has the country's biggest known deficit. Considering the tepid state of the stock market, rising life expectancies, the forthcoming labor shortage, and teacher contracts that critics say inflate pensions, many states are seeking ways to rework or even overhaul the way they provide retirement benefits to educators. "It's coming from every direction right now," Bernard Jump Jr., a professor emeritus of public administration at Syracuse University and an expert on publicly financed pensions, told *Education Week* in May 2005. "It's a very ugly time out there."

In February 2006, *USA TODAY* reported that Los Angeles school officials had discovered that their original estimate of $5 billion for their unfunded healthcare obligations for retirees was only half of the new, more realistic estimate of $10 billion. Currently, Los Angeles sets aside $1,000 of its $5,500-per-student budget to cover the healthcare cost of working and retired teachers. Covering the new $10 billion obligation would require $2,087 per student.

Most school districts across the country are not even aware of what they owe, but soon they will realize that they are unable to meet the financial obligations of these contracts. As healthcare costs continue to rise, such contracts will leave schools with less money to hire teachers to replace those leaving the workforce, less money for raises, and little option but to freeze pension programs for future teachers. In the end, it is children who will suffer most if the money required to support a quality education is not available.

The private sector's fiscal problems with healthcare obligations mirror those of public education and other state and local departments. On January 5, 2006, U.S. corporate giant, IBM, announced that it will freeze its employee pension plan beginning in 2008, making the company just one of many major employers that will no longer offer a monthly benefit to retired workers. To alleviate some of the strain, IBM reports that it will enhance 401(k) contributions for its 125,000 employees in the United States.

Although IBM currently is financially "healthy," its concern is the unpredictability of future cost of defined-benefit plans. Pension plans are "captive to the volatility of the capital markets," commented IBM spokesperson John Bukovinsky to *USA TODAY* in January 2006. In the same article, a former IBM employee now with the unionizing and advocacy group, AllianceAtIBM noted: "A lot of people, especially senior employees, are in a bit of a shock. They feel like the rug's been pulled out from under them."

General Motors Corporation (GM) is another example of how the private sector is scrambling to find strategies that will allow companies to meet their obligations to employees and former employees while ensuring future corporate health. The media, including *Time* and *Forbes.com*, have closely followed GM's efforts to buyout employee pension plans and use early retirement incentives to secure its financial footing for the long term. Analysts note that failure of such plans could result in the company going bankrupt, leaving employees and former employees with little or no possibility of collecting their promised retirement benefits. No matter what the strategies are, no matter what sector we examine, it is clear that the crises with pensions and social security will have far-reaching impacts on all areas of America's economic and social well-being.

Social Security and Medicare

Barring major cuts in spending, tax increases, or both, the national debt is projected to grow to $11.2 trillion in 2010, or about $38,000 for every person in the United States. Unless the American public and elected officials are able to agree on some difficult structural modifications to fiscal policy, our nation will experience a potentially devastating economic recession. Such changes will require sacrifice, and politicians tend to get cold feet when it comes to talking about the taxpayers' money. Leon Panetta, former White House budget director and chief of staff to President Bill Clinton, observes: "The choices you have to make [to balance the budget] are almost exactly the opposite of what wins political elections."

The aging population, a disproportionate ratio of retirees to job market entries, and healthcare inflation will spin the federal deficit out of control. In their 2006 annual report, presented on *CNNMoney.com* in May 2006, the trustees of Social Security and Medicare now estimate that the Social Security trust fund will be insolvent in 2040, while the Medicare trust fund will be depleted in 2018, earlier than previously projected. Consider the following, as outlined by Richard Wolf in *USA TODAY*:

- Prescription drug coverage under Medicare took effect on January 1, 2006. The projected cost of coverage in 2003 was $400 billion over 10 years. Current projections place the cost at more than $720 billion over 10 years.

- The number of people covered by Social Security is expected to grow from 47 million in 2005 to 69 million by 2020. By 2030, the Congressional Budget Office projects that Social Security spending as a share of the country's economy will rise by 40 percent.

- Baby boomers will be eligible for Medicare starting in 2011. If the cost of Medicare coverage grows just 1 percent faster than the economy – a conservative number – Medicare will cost $2.6 trillion in 2050 (after adjusting for inflation). This figure is about the same as the entire current federal budget today.

The current benefit package available for people who retire in their early- to mid-60s is undoubtedly attractive, especially since age 65 does not seem quite as "old" as it once did. Baby boomers who will become eligible for Social Security, Medicare, and employee pensions will be healthier and can expect to live longer than any other cohort in history.

Workers have looked forward to retiring at age 65 since Social Security was implemented in the 1930s. The retirement age has never changed even though life expectancy has significantly increased. In the 1930s, age 65 was still well beyond the average life expectancy, so most people worked until death. In addition, the retirement age helped to keep the American workforce fluid by continually pumping new employees into the jobs vacated by retirees as well as by those who died.

Today, the average retirement age is actually down to 62 years, but the average life expectancy is up to 77. Prolonging life was and continues to be a result of advancements in healthcare. Experts in geriatrics and genetics expect the increase in longevity we experienced during the last century to continue throughout this one. Even greater advancements and breakthroughs in healthcare and pharmaceuticals are predicted to keep the average American alive to the unfathomable age of 107 by the year 2100. If this prediction is realized, by the end of this century, an average American who lives until age 107, will have started working at age 21 and retired at age 62, meaning more years will be spent in retirement than in the workplace.

The business model of the American economy is driving it toward bankruptcy, and while it continues to benefit older generations, it is the younger ones that will suffer the most. The effects are already being felt in classrooms across the country: In the 2004 fiscal year, states spent 21.9 percent of their revenue on Medicaid; 21.5 percent on elementary and secondary education; and a mere 10.5 percent on higher education, according to a January 19, 2006, *USA TODAY* article.

Mega Trend #4 – New Generations in Our Classrooms

Millennials and Generation Z in Our Schools: The Implications for Education

As we strive to understand the students in our classrooms, it may be helpful to look at the characteristics of the two generations that currently are in our schools. Experts calculate that generations span about 22 years. Right now, the Millennials – born between 1982 and 1998 – and Generation Z – born between 1999 and the present – attend our schools.

The Millennials are predominantly students in middle school, high school, and college. They are children who are from the most "watched-over" generation by their parents and a generation that has grown up with and is fluent with technology. Their world has always had personal computers, cell phones, and the Internet. They are a generation that works well in groups and, as a result, they are very team-oriented. They are also a group that has maintained busy schedules growing up, juggling schoolwork, social interests, and myriad sports activities. As a result, they tend to be good multi-taskers.

Generation Z is still in elementary school. Because they are so young, not a great deal is known or understood about Generation Z, but they are beginning to be identified with certain trends. This, too, will be a generation of multi-taskers. They are a "connected generation" whose world has always had broadband and wireless access. The cell phones that they know facilitate multi-tasking. They are already fairly well acquainted with digital cameras and DVD recorders, MP3 players, gaming stations, Web browsers and text messaging devices. Generation Z will be the first generation to live into the 22nd century in large numbers.

These two generations provide our traditional classrooms with interesting challenges and opportunities. When this group is seen playing video games, those of us who teach often liken it to the passive activity of television watching as we knew it growing up. In fact, the similarities end when looking at the screen. Video games provide these children with an opportunity to role-play in a multitude of roles and scenarios. Additionally, the impacts of their decisions are immediately seen as the scenario is played out on the screen in a manner that, depending on the game, can be neither threatening nor intimidating.

These are youngsters who are sometimes accused of having short attention spans; however, researchers now believe that this is a group that has a strong ability to process multiple stimuli at once. They have always been able to work between multiple applications on their computers and electronic devices. Here again is their strong ability to multi-task.

Because these generations are multi-taskers and team players, our schools must be rich environments where students are presented with real-world problems that challenge their skills and empower their spirit of teamwork. They must feel that they have a level of control over their educational choices and, just as in video games, they must be able to accomplish each level and advance to more challenge levels. Teachers must engage these students in finding new ways to incorporate this generation's technological savvy into learning.

Writing in the December 2005/January 2006 issue of *Educational Leadership*, Mark Prensky refers to today's students as "Digital Natives." They are all native speakers of the digital language that drives cell phones, the Internet, and video games. Prensky explains that their teachers are the "Digital Immigrants," who generally struggle to learn this new language. Like all immigrants, educators can learn a great deal if they listen to the native speakers.

Middle Grades and Brain Research

In high schools, a rigorous curriculum without relevant application produces students who have demonstrated success in school, but who are unprepared for the challenges that await them in college or the workplace. A rigorous curriculum without relevant application and adaptation at the middle-grades level (grades six through eight) will transition students who may have been successful during these years, but who are unprepared for the challenges awaiting them in high school.

Preparing students to be successful in high school begins with a culture that supports rigorous and relevant curriculum and instruction at the middle grades for all students. Developing this environment starts with a complete understanding of how the brain develops during the critical period of early adolescence.

As noted earlier in this discussion, through molecular imaging, technology and science have provided educators with an emerging map of the adolescent brain that sheds some light on how this complex organ works at this stage of life. Middle-grades learners are moving from a world dominated by dependency on adults to a world of experimentation, exploration, and, ultimately, independence. The part of the brain most responsible for allowing rational decisions to be made is not fully developed, and reaction to situations is dominated by the emotional center of the brain that is saturated with highly active hormones. This challenges educators to provide rigorous and relevant curriculum and instruction that accommodates the uniqueness of the middle-grades learner. This can be accomplished by providing differentiated instruction to meet the varying levels and abilities of students, along with a flexible and safe environment that encourages students to challenge themselves without the fear of failure. It can also be accomplished by educators who:

1. Involve students in the collaborative establishment of classroom rules and procedures
2. Encourage the exploration of creative, alternative solutions to school and classroom tasks
3. Thoroughly explain the complex development and function of the brain so students can understand their own neurological state, helping to identify many of the major obstacles and challenges that they will face
4. Foster a supportive environment that allows for trial and error
5. Use multiple assessments such as portfolios, rubrics, teacher observation, and student performance to gauge student success and academic development
6. Encourage and allow for the development of each child at his or her own pace
7. Integrate cooperative learning and activities that stimulate positive student emotion, such as debates and real-world experiences
8. Understand that state assessments measure the foundation of the pyramid, not the peak

An additional factor that educators must take into account is the significant gender differences in the way that the adolescent brain develops. Male brains are slightly asymmetrical and larger than female brains. Female brains have more connections and process language in both hemispheres of the brain and have more finely tuned sensory systems, which allows girls to recognize details better than boys. Areas of the brain responsible for fine motor skills and language develops in boys six years slower than in girls, but spatial memory develops four years faster in boys. Lastly, female brains make neural connections from

the amygdala (the emotional center) to the prefrontal cortex (executive functions such as goal-setting, planning, organization, and decision-making) about four years earlier than males. These connections allow a child to understand his or her feelings and emotions and demonstrate mental flexibility in responding to all types of situations.

In order to provide a rich and meaningful middle-grades experience, educators must fully understand how the brain develops during this important stage. This knowledge will empower teachers to make curricular and instructional decisions that have effective impacts on learning. It also will lead to the creation of an environment that is conducive to learning, providing students with the opportunity to explore and experiment within the safe boundaries of the classroom. Experimentation and exploration will develop critical thinking and decision-making skills in middle-level learners and prepare them for the exciting challenges that await them in high school and beyond.

Skills for the 21st Century

The critical importance of providing students with the rigorous and relevant education that they need to not only survive but to thrive in the global economy cannot be overstated. The skills needed today are not the same as they were 50, 10, or even five years ago. The Information Age is about continuous progress and innovation. The externalization, standardization, and collaboration that technology fosters essentially make the world a smaller place. When you consider that computers are becoming more "intelligent" and less reliant on human interaction, all that is left is the sobering realization that the need for low- and medium-wage earners will decline dramatically in this country.

Today's students are already the most technologically proficient and collaborative group of individuals the United States has ever produced. If American education continues to emphasize rigor for outdated, 20th century standards, it is doing its young people a disservice. Schools can only prepare students to compete in the global economy by educating them with relevant 21st century skills. Introducing innovative technologies into educational settings will cater to students' learning styles and further their willingness and enthusiasm to learn as they better understand the connection between the classroom and their lives outside of it.

Public education in this country was originally designed to help select and sort students. In 2006, public education is no longer about selecting and sorting; it has evolved into a system that strives to prepare all students for their lives outside of school. There is nearly universal agreement that preparation for the future requires a strong academic base. This base, which is now being played out by state tests, is what is often referred to as academic rigor. The reality, however, is that state exams really do not measure academic rigor; rather, they measure basic academic skills. These tests are the beginning line of academics, not the end. The International Center is therefore committed to rigor so students are able to move beyond the minimum academic competencies measured by state examinations.

The *What* of Rigor, Relevance, and Relationships

Finding successful practices in K-12 education that adequately prepare students for a changing world has been the mission of the International Center for Leadership in Education since its inception in 1990. At that time, the International Center created a theme that addressed what needed to be done to prepare students for this changing world: rigor and relevance for *all* students.

The International Center has been gratified by the fact that numerous organizations throughout the country have picked up on this theme in the past few years. From the U.S. Department of Education to the Bill & Melinda Gates Foundation to many schools and districts, this theme has become part of their

ongoing work. The Bill & Melinda Gates Foundation has expanded the theme to include relationships, effectively updating the traditional idea of the "three Rs" of education. The International Center fully embraces this change, recognizing that all three of today's Rs are essential to prepare students for success in school and in life.

Nevertheless, while school districts across the country increasingly use the words rigor and relevance, those terms are seldom defined. At the International Center, rigor and relevance are more than catchy words; they are part of a framework for how to organize curriculum and instruction to prepare all students for the future.

Defining Rigor

Rigor refers to academic rigor, learning in which students demonstrate a thorough, in-depth mastery of challenging tasks to develop cognitive skills through reflective thought, analysis, problem solving, evaluation, or creativity. It is the quality of thinking, not the quantity, that defines academic rigor, and rigorous learning can occur at any school grade and in any subject.

Educators are cautioned not to rely on dictionary definitions of rigor when trying to modify instructional practice to meet community expectations for increasing rigor. One of the dictionary synonyms for rigor is the phrase "difficult." Just because something is difficult does not mean that it meets the test of sophisticated cognitive skills and reflective thought. It is possible to present students with very specific esoteric questions that are difficult, but which still require only simple recall of knowledge. Likewise, merely adding to the length of assignments may make it more burdensome and difficult, but this is not what is expected in rigor.

Another textbook definition of rigor is "rigid," as in *rigor mortis*. Some teachers may falsely try to instill rigor by becoming rigid in the due dates for homework or acceptable work, for instance. This inflexibility may or may not lead to improved student performance, but it certainly is not what is meant by increased rigor.

Defining Relevance

Relevance refers to learning in which students apply core knowledge, concepts, or skills to solve real-world problems. Relevant learning is interdisciplinary and contextual. Student work can range from routine to complex at any school grade and in any subject. Relevant learning is created, for example, through authentic problems or tasks, simulation, service learning, connecting concepts to current issues, and teaching others.

We all know of students who did extremely well academically but who seemed to be dysfunctional in the world beyond school. They seem to lack relevant skills for the real world. Rigor without relevance can enable a student to be successful in school, but to fail once they no longer have that structure and guidance.

The *Why* of Rigor, Relevance, and Relationships

To help educators better understand these concepts and their importance to creating high-quality educational experiences that enable student success in and beyond the classroom, the International Center created the Rigor/Relevance Framework™ in 1997. The Rigor/Relevance Framework is based on two dimensions of higher standards and student achievement: knowledge and application.

Knowledge Taxonomy

There is a continuum of knowledge that describes the increasingly complex ways in which we think. In defining rigor in this framework, we use the Knowledge Taxonomy, which is based on the six levels of Bloom's Taxonomy:

1. Awareness
2. Comprehension
3. Application
4. Analysis
5. Synthesis
6. Evaluation

The low end of this continuum – levels one and two and, to a degree, level three – involves acquiring knowledge and being able to recall or locate such knowledge in a simple manner. Just as a computer completes a word search in a word processing program, a competent person at this end of the continuum can scan through thousands of bits of information in the brain to locate desired knowledge.

The high end of the Knowledge Taxonomy – which includes high-level activity at level three as well as at levels four through six – labels more complex ways in which individuals use knowledge. At this end of the continuum, knowledge is fully integrated into one's mind, and individuals can do much more than locate information. They can take several pieces of knowledge and combine them in both logical and creative ways. Assimilation of knowledge is a good way to describe this high level of the thinking continuum. Assimilation is often referred to as a higher order thinking skill: at this level, the student can solve multi-step problems and create unique work and solutions.

Application Model

The second continuum, created by the International Center, is known as the Application Model. The five levels of this action continuum are:

1. Knowledge in one discipline
2. Apply knowledge in discipline
3. Apply knowledge across disciplines
4. Apply knowledge to real-world predictable situations
5. Apply knowledge to real-world unpredictable situations

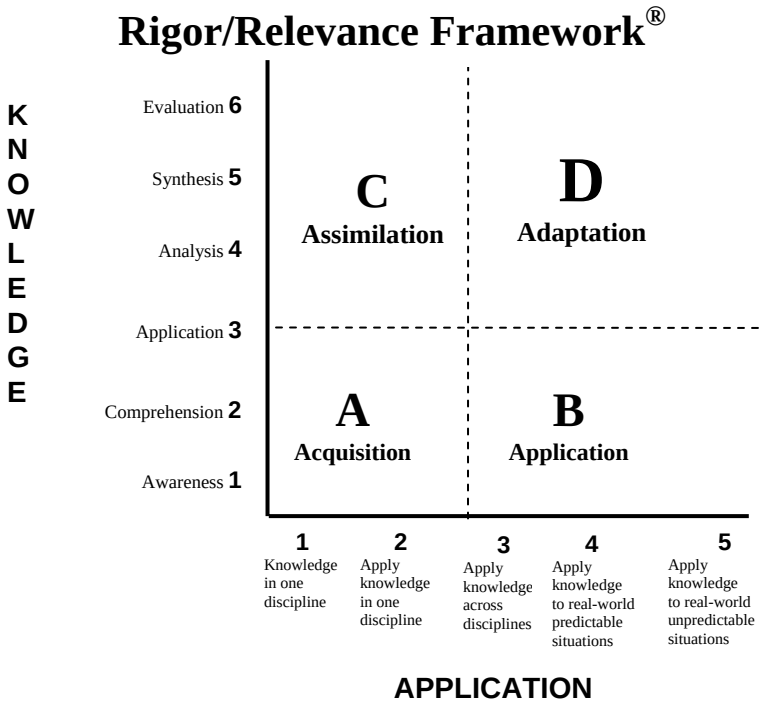
The Application Model describes how knowledge is put to use based on the levels of relevance. While the low end is knowledge acquired for its own sake, the high end signifies action: using the knowledge to solve complex real-world problems and to create projects, designs, and other works for use in real-world situations.

When instruction moves to high relevance, it is generally defined as "real-world," meaning the students' work is similar to that done by adults outside of school. The advantage of this is that students are more likely to be motivated to engage in learning since it is easier the see the purpose for learning. High-relevance learning also helps students retain their learning beyond the end of a chapter or completion of a test. Moving to higher relevance begins with an integrative approach including two or more disciplines, such as math and science, or history and language arts.

Using the Rigor/Relevance Framework

The Rigor/Relevance Framework, illustrated below, uses four quadrants that represent levels of learning. On the Knowledge axis, the framework defines low rigor as Quadrants A and B and high rigor as Quadrants C and D.

On the Knowledge axis, Quadrant A represents simple recall and basic understanding of knowledge for its own sake. Quadrant A is labeled "Acquisition" because students gather and store bits of knowledge and information.



Quadrant C, "Assimilation," represents more complex thinking, but still knowledge for its own sake. In Quadrant C, students extend and refine their acquired knowledge to be able to use it automatically and routinely to analyze and solve problems and to create unique solutions.

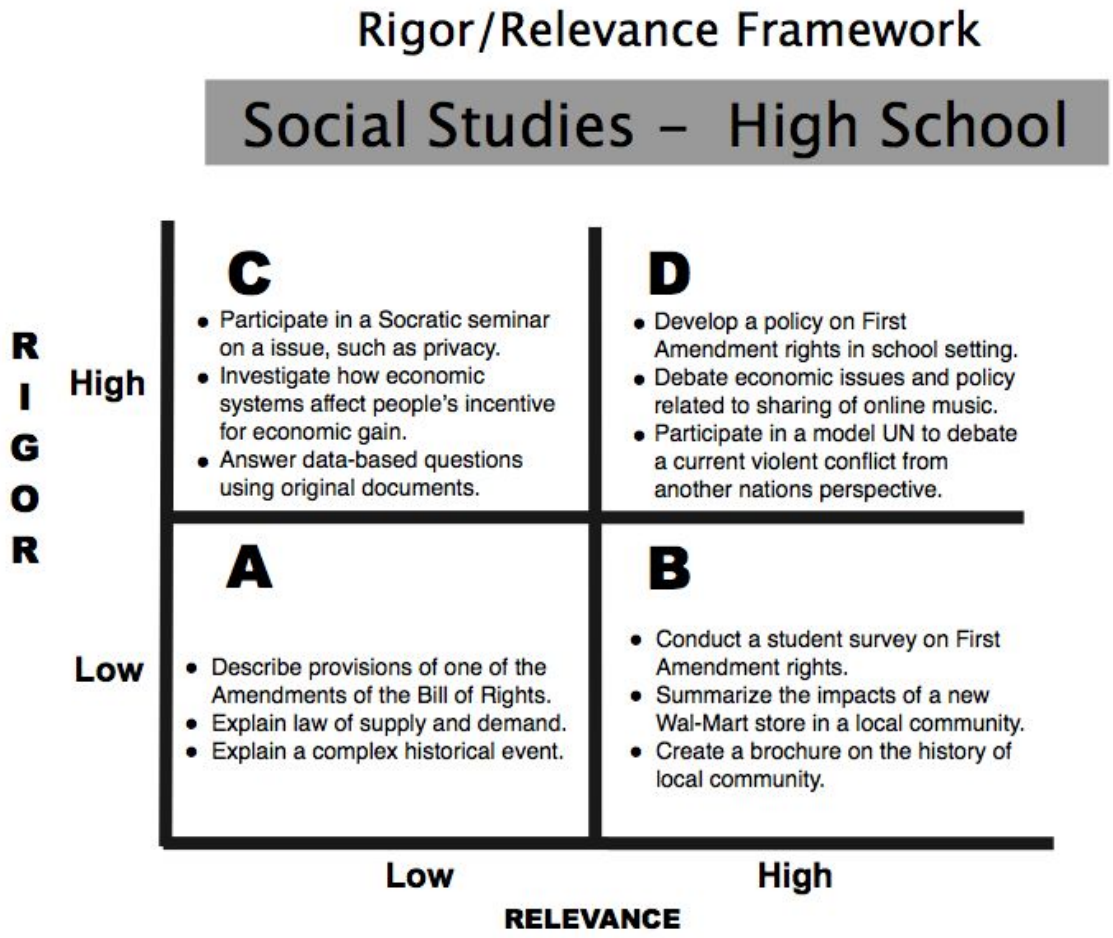
Quadrants B and D represent actions or high degrees of application. In Quadrant B. "Application," students use acquired knowledge to solve problems, design solutions, and complete work.

In Quadrant D, "Adaptation," students have the competence to think in complex ways as they apply knowledge and skills they have acquired to new and unpredictable situations. Students create solutions and take actions that further develop their skills and knowledge.

For students to become lifelong learners, problem-solvers, and decision-makers, Quadrant B and D skills are required. In effect, our students need to *know what to do when they do not know what to do*. The Rigor/Relevance Framework provides a structure to enable schools to move all students toward that level.

Applying the Rigor/Relevance Framework

The pictured example for high school social studies illustrates how the framework is used to define specific criteria for the curriculum and shows contrasting learning in each of the four quadrants. Notice the differences among these learning experiences.



Quadrant A is often abstract, discrete knowledge, and students struggle to retain this information beyond the required tests. Adults can look at these tasks and reflect that they knew this information once, but no longer remember the facts.

In Quadrant B, the learning is much more purposeful and, some would argue, easier to do. It just seems less difficult because the context is clear and hands-on experiences lend themselves to remembering longer after instruction.

Good instruction is not a choice of one single quadrant, but a balance. Some teachers approach instruction by teaching Quadrant A, low-level knowledge and require student mastery before proceeding to Quadrants B, C, or D. As a result, some students never get beyond struggling in Quadrant A, or the teacher runs out of time and moves onto the next topic. In such a model, students see learning as an unending series of academic hurdles, with no connection to their world.

Moving to high rigor and high relevance should be a forethought, not an afterthought. Teachers need to commit to involving students in Quadrant D and design lessons to facilitate that goal. Students – and

teachers – are more likely to succeed if high rigor and high relevance are the goals instead of optional activities.

Sometimes moving forward requires thinking backwards. For example, instruction may be more effective by introducing a real-world problem in Quadrant D first and allowing students to struggle with the problem. Then you can return to more direct instruction in Quadrant A to give students the background knowledge they may need to solve the real-world problem. This type of effective instruction covers multiple quadrants in rigor and relevance and is far more likely to motivate all students.

The *How* of Rigor, Relevance, and Relationships

Knowing that students need a rigorous and relevant curriculum to prepare them adequately for the future is the first step in school reform. Once people have agreed to the need for rigor and relevance, the difficult work then begins. How do we do it?

The International Center for Leadership in Education has had the privilege to watch some of the nation's highest performing schools deliver a rigorous and relevant curriculum to all students. In that process, we have learned some extremely important lessons. The first is to begin with the end in mind, for which it is essential to define your desired outcomes. We have created the Learning Criteria to Support Rigor, Relevance, and Relationships to assist schools in this critical step.

Learning Criteria to Support Rigor, Relevance, and Relationships

Together with CCSSO, the International Center has embarked on a five-year initiative to identify and analyze the nation's most successful high school practices and policies for achieving a rigorous and relevant curriculum for all students. Working with a dozen national groups representing many constituencies, the International Center has developed the Learning Criteria to Support Rigor, Relevance, and Relationships to identify proven high schools for this initiative and to help promising schools achieve proven status.

While the primary purpose for developing the Learning Criteria was to establish an objective process to identify successful high schools, the greatest benefit of these criteria, and one that applies to all schools, is the use of a data-driven system to measure student learning and to gauge progress in school improvement beyond standardized test results. The Learning Criteria is an innovative and positive approach for schools to implement changes that will result in rigorous and relevant learning for all students.

The Learning Criteria is intended to serve as the lens through which educators evaluate their performance in key areas. Using the Learning Criteria to measure success can help a school become more mission-driven and goal-focused. High performing schools that have worked with the Learning Criteria report that identifying data indicators has helped them specify what they believe is the true purpose of their school and what the school and community want students to know and be able to do in many aspects of life. State testing requirements are viewed as just one necessary component of this process, rather than the driving force behind it. A school can use the Learning Criteria to identify and evaluate areas of agreement and create, within the school community, a sense of ownership and responsibility for the direction in which the school will proceed. That vision can help maintain local accountability and control.

Arranged into four data categories, the Learning Criteria helps school leaders determine the success of their system, school, or classroom in preparing students for current assessments and for future roles and responsibilities. Regardless of its focus, a school should have data indicators in each of the categories below, and at least one indicator in each category should apply to the entire student population:

1. **Core Academic Learning**: Achievement in the core subjects of English language arts, mathematics, science, and others identified by the school

2. **Stretch Learning**: Demonstration of rigorous and relevant learning beyond minimum requirements, such as participation and achievement in higher level courses or specialized courses

3. **Student Engagemen**t: The extent to which students (a) are motivated and committed to learning, (b) have a sense of belonging and accomplishment, and (c) have relationships with adults, peers, and parents who support learning

4. **Personal Skill Developmen**t: (a) Measures of personal, social, service, and leadership skills and (b) demonstrations of positive behaviors and attitudes

The specific data indicators used will vary among schools based upon state requirements and schools' philosophies, focus, and curricula. To identify success, all data indicators must be quantifiable in the following categories:

- School Performance: Expressed in objective terms
- Sustained: Trend data show improvement or maintenance at high levels for three to five years
- Disaggregated: Comparisons in achievement among all subgroups
- Benchmarked: Compared to similar schools, schools in state, schools in nation or accepted norms from national/state surveys, reports
- Exceptional: Significantly exceed similar schools, schools in state, schools in nation or accepted norms

The process schools use to introduce the Learning Criteria to faculty and the school community varies depending on a school's size and organization, the leadership structures in place, and the extent to which the faculty is receptive to change. The Learning Criteria must involve more than simple data collection as it is necessary to reflect upon the appropriate indicators that are consistent with the school's goals and focus. It is important to note that once indicators are selected, not all of them will have data readily available, so the process may require additional data analysis or collection.

In order to address the complex demands of our society and the issues facing our students in a more competitive world, we must focus on the importance of instruction and continuous reflection about our practices, programs, and policies. Assessing and reflecting about the core academic learning of each and every student is necessary to school improvement. But if we only evaluate the core academic learning of all students, we are not capturing the whole picture of what we should be doing in order to provide them with the skills and knowledge needed for success in today's workforce. We must question our basic assumptions of how we are stretching our students to go beyond the minimum academic requirements. We must assess how we are assisting students with the personal skills needed for future success.

Unless we understand the importance of student engagement and address how we are keeping students motivated and focused on learning, it is not possible for each and every student to achieve core academic learning, stretch learning, or personal skills development.

Using Data to Evaluate and Improve the Rigor of Core and Stretch: State Tests

There is an increased focus on state assessments as a result of the No Child Left Behind Act of 2001 (NCLB), but are assessments moving schools in the opposite direction from students' needs? The International Center looked closely at one state test's ability to exercise equity among items that are both

rigorous and relevant. Specifically, the International Center analyzed the Comprehensive Achievement Tests for State X (CAT/X), using the 2002, 2003, and 2004 CAT/X exams for reading, mathematics, science, and writing. Each test item was evaluated using the Rigor/Relevance Framework. The percentages of test questions that map to the Rigor/Relevance Framework are shown in the series of tables below.

Reading

Percentage of CAT/X 10th Grade Test Questions within Each Quadrant of Framework

Rigor/Relevance Framework Quadrant	Percentage of Questions 2002	Percentage of Questions 2003	Percentage of Questions 2004
A	76	47	60
B	17	33	27
C	7	4	2
D	0	16	11

Mathematics

Percentage of CAT/X 5th Grade Test Questions within Each Quadrant of Framework

Rigor/Relevance Framework Quadrant	Percentage of Questions 2002	Percentage of Questions 2003	Percentage of Questions 2004
A	52	62	66
B	26	22	12
C	20	12	20
D	2	4	2

Science

Percentage of CAT/X 8th Grade Test Questions within Each Quadrant of Framework

Rigor/Relevance Framework Quadrant	Percentage of Questions 2002	Percentage of Questions 2003	Percentage of Questions 2004
A	56	68	71
B	8	1	13
C	28	20	9
D	8	0	7

Writing

Percentage of CAT/X 10th Grade Test Questions within Each Quadrant of Framework

Rigor/Relevance Framework Quadrant	Percentage of Questions 2005
A	39
B	24
C	4
D	33

The International Center has also crosswalked state standards (Arizona, California, Florida, and Texas for English language arts and mathematics, and California, Texas, and Washington for science) to the Curriculum Survey of Essentials Skills. The Essential Skills represent those standards most relevant to the

world outside of school as identified by survey responders. English language arts, mathematics, and science essential skills were matched to the standards for each individual state. For each discipline, the top-ranked Essential Skill for each discipline is crosswalked below. For each state, the number of state standards that match the essential skill, along with the state testing priority, is given (H=high; M=medium; L=low).

English Language Arts Essential Skill #1:

Apply in writing the rules and conventions of grammar, usage, punctuation, paragraphing, and spelling.

	Florida		California		Texas		Arizona	
ELA #1	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority
Grade 3	1	M	10	H	13	L	2	M
Grade 4	2	M	9	H	2	H	0	
Grade 5	2	M	5	H	13	L	1	H
Grade 6	0		0		15	L	0	
Grade 7	0		7	H	11	H	0	
Grade 8	0		6	H	12	L	2	M
Grades 9-12	0		13	M	5	M	1	H

Mathematics Essential Skill #1:

Perform operations with signed (positive or negative) numbers, including decimals, ratios, percents, and fractions.

	Florida		California		Texas		Arizona	
Math 1	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority
Grade 3	9	H	12	M	15	H	24	H
Grade 4	10	H	12	H	17	H	21	H
Grade 5	10	H	7	H	8	H	22	H
Grade 6	9	H	10	H	10	H	20	H
Grade 7	9	H	6	H	6	H	13	H
Grade 8	9	H		H	3	H	9	M
Grades 9-12	3	H	5	H	3	H	2	M

Science Essential Skill #1:

Find how and why the rotation and revolution of the Earth around the sun affects the length of night and day, the changing of seasons, and weather patterns.

	Florida		California		Texas		Washington	
Science 1	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority	# of State Standards Matched	State Testing Priority
Grade 3								
Grade 4	1	H						
Grade 5					2	H		
Grade 6								
Grade 7								
Grade 8								
Grades 9-12	2	H						

Developing Relevant Lessons

Developing relevant lessons for state standards is a difficult task. Reading an example of a lesson that is considered high rigor/high relevance is one way to begin building an awareness of this process. Reading 100 lessons may be an even greater experience, but without actually developing a highly relevant lesson of your own, that is like having 100 cakes without a single recipe.

High relevance lessons are those that apply knowledge across disciplines and to real-world – both predictable and unpredictable – situations. Developing a high-quality lesson requires (1) identifying student learning, (2) writing performance tasks, (3) linking to state standards, (4) creating scoring guides, and (5) describing teacher procedures.

The actual process of developing high rigor/high relevance lessons is as important as the products that result, and it is most effective when done collaboratively. As people work together to make suggestions, share ideas and perspectives, the process of thinking about and developing a lesson exercises the theory behind the Rigor/Relevance Framework: "student think/student work." When immersed in this process with others, relevant learning occurs and opportunities are created.

The first step in creating relevant lessons is identifying the concepts, knowledge, skills, and behaviors of the students. As a group, educators can deliberate over content, but the categories themselves are defined as follows:

- Concepts: the "big ideas" most important for students to learn and retain
- Knowledge: the core facts, such as key vocabulary and significant dates in history
- Skills: the mental processes, such as reading, measuring, and editing
- Behaviors: the personal traits or manner of doing things, such as taking a leadership role

Next comes creation of the performance task, the description of how the students will demonstrate the learning. Typically, this includes an overview and more detailed description of the activity. It is important to keep in mind that students who are given opportunities to apply their learning to real-world unpredictable lessons are more likely to retain the concepts. An example of this is asking students to collect weather data for a particular location and then having them select the most appropriate statistical tools to analyze the information. Working collaboratively, teachers may use weather as a theme across disciplines, providing opportunities for students to make connections.

Linking the lesson to state or national standards, the third step, is a way to validate the activity. A group can work together to make this list as comprehensive as possible.

The way in which student understanding is assessed is a critical ingredient to an effective lesson, hence the fourth task: developing scoring guides. Scoring guides, such as rubrics, are a great tool for breaking down the component of an activity to fully capture what students learned. Rubrics are more descriptive and informative than a simple letter or number grade. Comparatively, this type of assessment may be extremely time consuming, but the benefits outweigh this negative. Students realize that this is a time-consuming task for a teacher, and this can translate into a stronger relationship. Teachers who take the time to look more deeply at student work and provide not only suggestions for improvement but positive reinforcement are setting the tone for a committed and caring investment in the student's education.

Finally, teacher procedures, student activities, and exemplars are included in the lesson. This offers a more detailed explanation of the roles both teachers and students take. Exemplars of student work may also be shared to highlight student understanding and help to describe expectations more concretely.

The International Center has created an online staff development tool to facilitate development of high rigor/high relevance lessons. Collaborating Online for Rigor and Relevance (CORR) is a way for teachers to share ideas and lessons from their computers. An electronic template allows teachers to enter elements of the lesson. This information is stored in a database and can be retrieved, edited, and stored again. Others can view the lessons and provide feedback throughout the editing process. Teachers who are well versed with the Rigor/Relevance Framework are not only able to develop quadrant D lessons, but also are able to fluidly move between quadrants; the most effective teachers balance rigor with relevance.

Reading and Mathematics Demands: School vs. Real World

Teachers are challenged to examine basic assumptions in reading and mathematics as they move instruction and assessment to high levels of relevance, as defined by the Application Model and quadrants B and D of the Rigor/Relevance Framework. First, it is nearly impossible to avoid interdisciplinary instruction when designing relevant, real-world learning. Any real-world application of history or science naturally requires application of mathematics or language skills. At first, this appears to be a plus by creating opportunities to reinforce the basic application of reading and math. But proceed with caution, because real-world applies here.

Traditional teachers may be accustomed to a level of reading comprehension set by the education community but devoid of anything real-world. The reading levels of textbooks and state reading tests are set by groups of teachers who are familiar with the current reading level of students in school. They subjectively set a level of comprehension that they feel students should rise to meet. The real world does not consider a student's level.

Student learning styles are like fingerprints or DNA: they are different for everyone. In a classroom situation where, for example, the teacher is lecturing or the students are reading a passage from a textbook, one can guess that only a fraction of the students are experiencing the appropriate amount of instructional material for the lesson to be effective. Students who find the lesson too rigorous become lost and discouraged. Other students may not be challenged enough and become bored.

Ideally, each student will experience measurable and sustained improvement from class to class, day to day, and grade to grade. By the time a student graduates from high school, he or she should have gained the requisite skills to succeed in the next stage of life, whether it is college or the workplace. If a student can step seamlessly into that next phase, then the education system has worked for that individual. If all students can make that transition, then the system on the whole is succeeding.

But we know this is not happening. In fact, it has not happened since long before the publication of *A Nation at Risk* in 1983, which concluded that American schools were in danger of not preparing students to compete in the 21st century. NCLB is a continuation of the push for improved academic achievement and proficiency. American education has responded by increasing academic rigor at the expense of developing a relevant, 21st century skill set.

In 1983, the impetus for change came primarily from the business community, not from higher education, whose own slipping standards continue have allowed for more and more "developmental" English courses to backfill academic deficiencies among entering freshmen. Business and industry continue to feel firsthand the skills gap between what students are learning in school and what they actually need in order to be competitive in the modern, high-tech, global economy.

Consider the skill of reading. The business community has long identified inadequate reading proficiency as a leading problem among entry-level employees. Educators have attempted to solve the problem by assigning more reading, mostly literature. The problem with this is twofold.

First, assigning more reading will not usually result in higher reading proficiency. A student at a certain reading level will not improve his proficiency unless he is continually challenged by the text. A student who reads a text that is at or below his reading level is not being challenged. Conversely, a student presented with a text well above her reading level will find it too complex and grow frustrated. A text needs to be slightly above a reader's ability level to promote growth in reading proficiency.

Second, prose is not read in most workplace situations. Literacy in the context of work requires better technical reading skills for understanding documents and quantitative material. Students need to be exposed to a variety of texts, not just from other content areas, but from career and technical education courses, personal-use or adult-roles texts, and sample occupational materials. The modern definition of literacy needs to encompass all three types of text: prose, document, and quantitative.

Now consider mathematics, which presents a slightly different scenario. Research is very preliminary as to the level of application of math in the workplace. What is clear is that there are vast differences among career clusters, and there is less of an opportunity to generalize across careers about the real-world applications.

One observation at the high school level is that mathematics instruction is out of step with interdisciplinary and real-world application. In most learning experiences in career and technical areas, economics, or science, the mathematics that are most often required are fractions, measurement, or statistics. When seeking opportunities to collaborate with a high school math teacher, the answer often something like, "Sorry, that was covered in earlier grades, and we have moved on to . . ." Unfortunately, the earlier "coverage" by mathematics teachers has left students devoid of the application and fluency necessary to do the real-world mathematics in these subjects. Teachers in these subjects often end up re-teaching mathematics to enable students to complete their work. In the area of mathematics, venturing into relevance requires application of mathematics that many students have not acquired.

The Lexile Framework® for Reading

The International Center has researched the level of reading in the real world, as measured by the Lexile Framework® for Reading. This innovative approach to reading comprehension is being widely adopted and implemented in schools across the United States. Lexile measures, as components of the incremental Lexile scale, allow for measurement of both text difficulty and reader ability on the same scale. This enables readers to be appropriately matched with books that will be both engaging and challenging.

Unlike grade equivalent measures of readability, the Lexile scale is based on uniform increments from 200L to 2000L. Using this scale, an increment of 100L is constant in terms of increase in semantic and syntactic complexity; a one-grade difference expressed in grade equivalents, however, is not. For example, the difference in reading difficulty between 3.2 and 4.2 may be much greater than the "one-grade" difference between 9.2 and 10.2. Moreover, Lexile measures avoid the problem of labeling reading expectations for a particular grade level; referencing Lexile measures also reinforces the notion that reading abilities differ broadly within any grade.

Findings of a comprehensive research study using the Lexile Framework were reported at the 2003 Model Schools Conference. The findings showed a gap between students' reading levels and real-world reading requirements. The greatest gap among texts analyzed was between the reading requirements of workplace materials and literature assigned in schools. The International Center conducted a detailed study of the

readability levels of a wide array of print materials encountered in the workplace. These occupational reading materials were linked to the 16 Career Clusters defined by the U.S. Department of Education at three job levels: entry, intermediate, and advanced. The International Center's Lexile analysis revealed that a large number of entry-level jobs have higher reading requirements than are required for high school graduation.

The International Center recently concluded a new round of research using the Lexile Framework with more than 60 Successful Practices Network (SPN) high schools. As part of the study, the International Center asked the SPN schools to submit a variety of reading samples used in their classrooms – such as high school literature and textbooks and first-year college literature and textbooks – as well as reading materials found in their community, including armed forces texts, entry-level occupational texts from local businesses, and personal-use or adult-roles texts, such as tax forms, insurance policies, and loan applications. The study shows that a reading gap still exists.

The list that follows shows the interquartile ranges of Lexile measures (25^{th} percentile to 75^{th} percentile) of the texts analyzed as part of this most recent study.

Sample Group	Interquartile Range of Lexile Measures
High School Literature	730-960L
First-year College Literature	815-1050L
High School Textbooks	960-1140L
First-year College Textbooks	1095-1320L
Armed Forces Texts	1170-1225L
Personal-use/Adult-roles Texts	1160-1358L
Entry-level Employment Texts	1170-1380L

From this list, it is easy to see the reading challenge: even more so than the real world, post-secondary education requires substantially higher levels of reading proficiency than most students possess. States need to be sure that the reading proficiency levels they set under NCLB account for not just traditional academic measures of reading competence, but also the skills that make individuals employable and successful in their lives after graduation. This broader view of reading competency is an example of the academic proficiency that must become part of program improvement under NCLB.

The Quantile Framework® for Mathematics

MetaMetrics, developer of the Lexile Framework® for Reading, also has developed a framework of mathematical ability. The Quantile Framework® consists of a common supplemental metric for the measurement of mathematical ability call the Quantile. The Quantile measure for materials is a number indicating the mathematical demand of the material in terms of the concept/application solvability. The Quantile measure for an individual or student is the level at which he or she is ready for instruction (50 percent competency with the material) and has knowledge of the prerequisite mathematical concepts and skills necessary to succeed. The Quantile scale ranges from Emerging Mathematician (0 Quantiles and below) to above 1400 Quantiles for the content typically taught in algebra II, geometry, and precalculus.

In addition to the Lexile study with SPN schools, the International Center also asked the schools to submit a variety of math lessons used in their classrooms – such as high school and first-year college – as well as materials that involve mathematics found in their communities, including personal-use or adult-roles materials and employment materials from local businesses.

The initial findings are remarkable. The mathematical demand of high school and first-year college lesson materials far exceed the demands of employment and personal-use or adult-roles materials; this is a complete reversal of the skills gap in reading. Why? The math we use in our daily lives and even in our jobs simply does not typically involve the rigorous demands of a high school lesson. Naturally, some occupations require mastery of precalculus and algebra II, but on the whole, most do not. The math we do in our personal lives is even less rigorous.

These studies highlight the truly fundamental difference between reading and math. To become a lifelong learner and succeed in life, individuals must be reading literate in prose, document, and quantitative texts. Beyond high school, most individuals need only be math literate in day-to-day activities and in their careers, which vary widely by occupation. For instance, an accountant requires a greater degree of statistics competency than geometry, but the opposite applies for a carpenter.

The high rigor of high school mathematics courses is necessary to provide a well-rounded basis for students, who may later decide to follow a particular career path based on his or her math aptitudes and interests. However, rigor needs to be balanced with relevance to make the instruction worthwhile for all students.

Student Aspirations Survey

As part of its partnership with CCSSO and the Bill & Melinda Gates Foundation that focuses on highly successful high schools, the International Center has embarked on a five-year journey to move 75 high schools from "promising" to "proven" models of success. The initiative, "Models, Networks, and Policies to Support and Sustain Rigor and Relevance for All Students," is designed to identify, analyze, and disseminate the nation's most successful school-wide practices and policies for providing a rigorous and relevant curriculum to all students.

One important criterion when identifying proven schools is the level of engagement and connectivity that the students have and feel toward their schools. Trying to gauge this is a difficult task because of the highly subjective and transparent nature of human emotion. Although impossible to substantiate, but often times highly accurate, is the first impression that one gets when walking into a school for the first time. Almost immediately one can tell if students are engaged and highly connected to their school, or if something is missing.

Highly successful schools understand this and diligently attempt to accurately measure student engagement and connectivity by analyzing such factors as graduation rates; attendance rates; availability of and enrollment in Advanced Placement courses; student involvement in co-curricular activities and athletics; and the number and types of disciplinary infractions that occur in their schools. These schools create and implement programs to build student engagement and develop positive school climate. Schools invest time and resources to get a sense of how students perceive their school through surveys designed specifically to measure these factors. Schools then use this information to revisit their mission and goals or to adjust programming.

To assist schools in this endeavor, the International Center has introduced the 75 "promising" schools noted above to the *My Voice Student Aspiration Survey*, designed by Dr. Russell Quaglia of the Quaglia Institute for Student Aspirations. The survey measures engagement and connectivity by assessing student aspirations through the 8 Conditions that Make a Difference: (1) Belonging, (2) Heroes, (3) Sense of

Accomplishment, (4) Fun and Excitement, (5) Curiosity and Creativity, (6) Spirit of Adventure, (7) Leadership and Responsibility, (8) and Confidence to Take Action. The survey asks students to respond to questions in each of the eight conditions. In total, students respond to 68 statements by selecting one of five responses: (1) Strongly Agree, (2) Agree, (3) Undecided, (4) Disagree, and (5) Strongly Disagree. The questions are designed to measure how students perceive their school environments. The data provide valuable insight into what motivates students to achieve and learn and how students believe their schools are meeting those objectives.

Currently, the International Center, working with the Quaglia Institute, has analyzed the results of more than 40,000 of these surveys representing a diverse population of students from more than 50 schools in 10 states. The insight being gained from this analysis is startling.

According to Dr. Quaglia, one of the survey's most revealing statements is, "I am proud of my school." Response to this statement indicates student engagement and connection to the school, the very essential ingredient to achievement. Sadly, only 49 percent of the students surveyed agreed with this statement. How can students be invested in their education if they are not proud of their schools?

Equally disturbing are the perceptions that students share about teachers. Forty-four percent of students agree that their teachers care about students' problems and feelings; 49 percent agree that teachers care about them as individuals; and 31.7 percent believe that teachers make school an exciting place to learn. Of course, few educators would agree with these low percentages, but these are the students' perceptions. How can schools change this situation? How do educators communicate to students that they care about them and want to help them achieve their greatest aspirations?

Two common factors associated with student disengagement are boredom and a lack of connection to curriculum and instruction. Disturbingly, 46 percent of students believe school is boring, and only 39.7 percent believe that their classes help them to understand what is happening in everyday life. Can rigorous and relevant classes change this perception? What do schools and teachers need to do make education more practical and applicable to real-world situations?

The *My Voice Student Aspiration Survey* also found significant differences in perceptions about education by gender and by racial background. Throughout the survey, males scored consistently lower than females regarding the eight conditions, especially in the areas of academic achievement and effort. Females care more about the grades they receive than males and are more eager to share this information with friends. Somewhat surprisingly, surveys show that African-American and Hispanic students report more than white students that:

1. They enjoy being at school
2. That their classes help them to understand what is happening in their everyday life
3. Tests are an important part of education
4. They put forth their best effort at school
5. They learn new things that are interesting to them at school

The one area that showed great consistency in all student population groups was the parent category. Of all students surveyed, 93.9 percent believed that their parents cared about their education, and 90.6 percent believed that their parents thought going to college was important. Just 60.9 percent believe that their parents felt comfortable talking with their teachers, and only 37.4 percent agreed that teachers let their parents know what they do well.

We are finding that highly successful schools perform significantly above the mean in all eight categories. Three such schools are Academy High School in Kingsville, Texas; Raleigh Charter High School in

Raleigh, North Carolina; and YES College Preparatory Charter School in Houston, Texas. These schools' students responded much more positively to the majority of the statements on the survey. To the all-important statement "I am proud of my school," 73.7 percent of the students at Academy; 81 percent of the students at Raleigh; and 70.2 percent of the students at YES agreed, compared to the survey average of 49 percent noted previously. The survey average for positive response to the statement "Teachers care about my feelings" is 44.5 percent. Remarkably, 70.7 percent of the students at Academy, 61.2 percent at Raleigh, and 63.4 percent at YES agreed with that statement. These are just two of many examples that help to distinguish these schools as highly successful.

Across the board, schools that significantly score above the mean percentages on the survey share common factors, including:

1. A clear and concise mission that supports rigorous and relevant curriculum and instruction
2. Providing students with opportunities for real-world application of skills and knowledge
3. A clear and unwavering belief that all students can be successful.
4. A faculty and staff committed to making sure that no child "falls through the cracks"
5. A faculty and staff that develop supportive and positive relationships with students
6. A faculty and staff that instill trust with their students

If student perception is to change, then schools must be willing to closely evaluate their structures to ensure that these factors exist. Such factors engage students in learning and help them feel connected to their school. The result is a school that speaks with a voice that is shared by students and faculty alike. Schools that are successful at creating a shared voice will become proven models of success.

Putting the Pieces Together

To assist educators in putting the pieces together to achieve a rigorous and relevant curriculum for all students, the International Center for Leadership in Education has created a series of initiatives. These initiatives bring to districts and schools the nation's most successful practices and leaders in the area of rigorous and relevant instruction. Their expertise, guidance, and ongoing support have proved to be critical to the success of many schools throughout the country. Some of the initiatives and services are described below.

Symposium

Each fall the International Center conducts a three-day symposium designed for districts and school teams from the middle level and high schools to create a plan of action for creating a rigorous and relevant curriculum for all students. The symposium includes:

- a demonstration of what successful school reinvention looks like in different types of schools
- in-depth analysis of unifying components and characteristics found in all types of successful schools
- technical assistance to help these leadership teams think through and develop a process to move from traditional schools to ones that are highly effective for all students
- successful practices to guide schools in developing their individual plans.

Successful Practices Network

The International Center created the national Successful Practices Network in 2003 to provide technical assistance to schools. The Network is an alliance of more than 600 schools (K-12) that have made a true commitment to continuous school improvement. The Network is based on a comprehensive analysis of school improvement research, which has yielded 10 key components that are used as a platform for Network initiatives:

1. **Culture of High Expectations and Support** – Create a culture that embraces the belief that all students can benefit from a rigorous and relevant curriculum and that provides personalized relationships between adults and students to support high levels of achievement.

2. **Data-driven Decisions** – Use data to provide a clear, unwavering focus to curriculum priorities that are both rigorous and relevant, instruction that is personalized and school improvement that is continuous.

3. **Accountability** – Set high expectations that are monitored, and then hold both students and adults accountable for students' continuous improvement in the curriculum priorities.

4. **Articulated Curriculum** – Use a framework to organize curriculum that drives instruction toward both rigor and relevance and leads to a continuum of instruction between grades and across disciplines.

5. **Rigorous and Relevant Instruction** – Teach students through experiences that are challenging, stimulate reflective thought and involve real-world applications of skills and knowledge.

6. **Personalized Learning** – Create appropriate transitions into and from school and multiple pathways to rigor and relevance based upon a student's interests, learning style, aptitude, and needs.

7. **Professional Learning Communities** – Foster development of a highly collaborative staff and provide sustained professional development focused on the improvement of instruction.

8. **Partnerships** – Obtain and leverage parent and community involvement resulting in positive relationships with schools.

9. **School Climate** – Establish and maintain a safe and orderly school.

10. **Leadership** – Offer effective leadership development for administrators, teachers, parents, and community.

Leadership Media

The International Center publishes a wide variety of materials for planning and conducting professional development workshops for administrators and teachers. Resource kits combining print and electronic materials cover such topics as rigorous and relevant curriculum, school improvement, instructional strategies, reading, and writing in the content areas, small learning communities, special education, career and technical education, and character education. Gold Seal Lessons based on state standards and matched to high-priority topics on state assessments are available in mathematics, science, and English language arts for grades K-12. Broadcast-quality video presentations featuring Dr. Daggett are produced every year at the Model Schools Conference.

Partners

The International Center has partnered with several other organizations to assist schools in moving to a more rigorous and relevant curriculum. Several of those partners are introduced below.

Kaplan K12 is a welcome partner to the International Center. Schools need a comprehensive curriculum that is vertically and horizontally coordinated and based upon good data that identifies what is essential, merely nice to know, or not necessary. In the past, state departments of education and school districts had curriculum divisions that developed this material for their schools. In recent years, curriculum development resources have been depleted at both the state and local levels. Emerging in their place have been other organizations that have developed high-quality curriculum that enables students to obtain a rigorous and relevant education. We have found Kaplan K12 to be the national expert in curriculum development. For information of how to connect with the curriculum development initiatives provided by Kaplan K12, please contact the International Center.

Scholastic and the International Center share a common belief — no area is more important to students' future than reading. Today's students must become lifelong learners, and good reading skills are essential to that. Unfortunately, many schools have not developed a comprehensive K-12 reading program. Instead they have a reading program designed for K-6, with reading in grades 7-12 being relegated to remedial programs for those who have not succeeded in reading in K-6. Our experience shows that this is short-sighted and leaves many students dramatically deficient in terms of the reading skills they need for success in the 21st century. The best program we have found to address this is Scholastic's *READ 180*. Therefore, we have joined hands with Scholastic to help put together quality programs that will enable all students to become proficient readers for an increasingly sophisticated and demanding world in which they will live. For information on the *READ 180* program, please contact Scholastic or the International Center.

MetaMetrics is another of the International Center's valued partners. MetaMetrics is the creator of the Lexile Framework® for Reading, a powerful tool for reading measurement and literacy development. International Center consultants assist schools, parents and the business community to apply the Lexile Framework's unique system, which places readers and reading materials on a common scale. MetaMetrics has also created the Quantile Framework® for Mathematics for a similar purpose — to place learners and learning materials on the same scale.

USA Today Education, a long-time partner of the International Center, provides timely and relevant resources for students and educators. Its cross-curricular daily lesson plan and online resources can add rigor and relevance to any curriculum and learning process, while helping educators develop avid readers and informed citizens. The high-impact materials stimulate critical reasoning and analytical skills in mathematics and science classrooms by engaging students in USA Today's real-world content and curricular materials integrated with educational technology.

TypeMatrix is one of the International Center's newest partners. TypeMatrix is the developer and distributor of the EZ-Reach 2030, an ergonomic keyboard with full-size keys arrayed in an integrative grid pattern that reduces repetitive stress injury, increases typing speed and accuracy, can switch between QWERTY and Dvorak keyboards, and allows keying in English, French, or Spanish.

The International Center will continue to put together comprehensive initiatives and partnerships to assist schools in more adequately preparing all students for a rigorous and relevant curriculum. For information on successful programs, practices, or materials, please contact the International Center.

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