A New Science of Education:
Five Trends That Will Dominate the Future
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There is a new science of education emerging which is being distilled from a coalition of five trends that will have an extraordinary impact on the history of education. These trends all have the happy characteristic of being in their embryonic stages, which insures that they are just starting a virtuous cycle of ever-improving capabilities and falling costs associated with new technological solutions that are ready to scale in high volumes. The chief characteristic of this new science of education will be its ability to offer outstanding individual, interactive artistically stunning instruction inexpensively in non-formal educational settings such as the home.

The five trends that will change today's educational system dramatically are:

(1) Technology

(2) Instruction

(3) Access

(4) Motivation

(5) Research

Their great strengths will allow them to revolutionize education because the traditional educational delivery system has fully matured, leaving little or not room for improvement. On the other hand, the new trend areas are in their infancy with ever-accelerating capabilities and declining costs which will insure universal access.

TECHNOLOGY: Understanding the Power of Doubling

Although instructional technologies such as computers, data storage, and the Internet are thought of as mature technologies, they are not. Computers continue to improve in speed and storage at about 1% a week (doubling about every two years) without any increase in cost. This doubling phenomenon takes a while to become visible, but the further along the curve, the greater the potential doubling. For example, the first microcomputer chip, the Intel 4004, was released in 1971 with 2300 transistors. It was about the same power as the ENIAC, which was the first serious computer built 25 years earlier at the

University of Pennsylvania. The ENIAC weighed 30 tons and was powered by 18,000 vacuum tubes.

In 2010 the newest doubling will enable chips to have two billion transistors, which suggests unimaginable potential in comparison to the 2,300 available only 40 years earlier. Soon the doubling will be in the trillions. Both the Internet and wireless technologies will also continue to improve at a lower cost.

The difficult concept for most people to understand is that education is increasingly entering an era where almost unlimited power will be available to an individual in his or her home for receiving interactive individualized instruction of previously undreamed of quality.

INSTRUCTION: Educational Software is Approaching Usable Maturity

Software is the variable that allows the new increasing power of the computer to become useful in any human endeavor. Microsoft's Bill Gate's great contribution to this effort was to develop inexpensive software that allowed the new power to be useable for a host of business and personal applications. : It has taken educational developers longer, but after about 40 years of development, educational software is now emerging that is powerful enough to begin to offer advantages that a standard classroom alone cannot match. Some of these advantages are:

- **Individualized Instruction**: The average elementary classroom is fortunate if it can give each child one minute of individualized instruction a day. Conversely, in a typical computer-based reading program in the classroom, a child can easily have 15 to 30 times the individualization in a given day. Using sequencing techniques, the computer software can craft a unique instructional sequence for each child based on real-time need.
- **Interactivity Rather Than Passivity:** Computer software forces students to become active participants. The computer requires the student's attention and interactivity, and it does not allow gaps and lapses in student learning because the software tracks progress and adjusts the program to insure understanding.
- **Immediate Feedback: With interactive software, e**very learning trial receives immediate feedback, an optimal strategy in mastering new materials and

cementing old ones that may have been shaky. The computer also has infinite patience and allows constant repetition without comment or judgment.

- **Undiluted Curriculum:** Most children are exposed to or learn only a diluted and partial curriculum because of attendance issues—involving either the teacher or the students—, the lack of student attention during class time, or because of poor teaching. Technology is not immune to attention issues, but it has three unequivocal advantages. It can insure that all **of** the curriculum is available and taught in a proper sequence; it can insure mastery before moving on; and it can be buttressed by spectacular artistic presentations with music, graphics, and animation to insure student interest and willingness to use the materials over and over.
- **Minmal Disconnects from the Ideal Curriculum**: The common denominator in many schools' problems is that students disconnect from the sources of instruction (teachers, books, audiovisual devices, etc.) available to them. Most disconnects come from a myriad of student reasons (cutting class, daydreaming, peer pressure, chasing social myths, dating, boredom, fear, anxiety, athletics, etc.), but some can be introduced by poor teaching. One of the little-noticed disconnects is the disparity of what may be available in instruction to the student compared to what the latest research is showing as effective. Most teachers can update their expertise sporadically at best, and many simply continue to teach what they are familiar with and have been trained to believe is effective. Here technology has an awesome advantage in avoiding a disconnect with the latest research because technology-based education is updatable overnight. Research can go from the laboratory to the product very quickly compared with the decades it takes currently to reach textbooks or practicing teachers.

ACCESS: Inexpensive Convenient Access—From Scarcity to Abundance

Once the newly connected hardware becomes ubiquitous, the hallmark of the new technologies will be their ability to provide inexpensive and convenient**,** access to outstanding education anywhere and at any time. Thus sources of instructional will morph from being scarce (the limited school calendar) to becoming abundant (time at

home). As futurist, Alvin Toffler has noted, these new sources of energy connected by the Internet and wireless technology will allow access to work or instruction at home, or wherever we might be, instead of requiring us to travel to gain access to offices or schools. These new instructional capabilities will also be scalable without requiring the construction of new physical plants or hiring new personnel to staff them. Offices and schools will continue to exist, but the work they support will also be available elsewhere, where it will be inexpensive, convenient, and more effective under some conditions than the traditional settings. Scarcity is synonymous with high cost, and abundance with low cost; as millions of homes are served, the price will drop to pennies per hour of instruction.

MOTIVATION: Usage as King

This new education science will beget extensive research in motivational strategies because many of the traditional motivators such as school teachers, administrators, or even well trained parents, will not always be present. Instead, the materials themselves and a new support organization built by the materials' providers will have to generate motivation for the children (and adults) using them. Decades of research have shown that usage is the critical variable for success, but, unfortunately, there is little understanding of its importance.

Past evaluations of computer effectiveness in school instruction have rarely paid attention to usage. In one rigorous study in New York City, children were scheduled to use the computers daily for 25 minutes in a laboratory under the guidance of a paraprofessional and their teacher. While both observers and teachers reported full attendance, computer logs revealed that an average of all classes being measured used the materials less than 25% of the scheduled time. In another more recent government study that reported on the effectiveness of software from five different vendors, researchers concluded there was little actual gain. But when the usage data was evaluated, it revealed that the computers were turned on less than 20% of the school days in the year, and the total usage was far less than scheduled. When not part of the daily routine, the lack of usage becomes the ultimate disconnect. The goal of the new motivational research will be

to “institutionalize usage” so that children and parents assume that 15 minutes usage a day, for example, is a standard norm, like brushing teeth or practicing the piano.

RESEARCH: Brains and Data Bases—From Approximation to Precision

The new technologies will soon make outstanding individualized and interactive instruction available inexpensively in every conceivable setting. As the software industry matures, the new instructional materials will be presented in dazzling artistic settings and supported by superb motivational strategies. Perhaps even more significantly, two relatively new areas of research will help inform instructional strategies as they relate to the new technologies: the study of the human brain; and the construction of powerful new student data bases **stored** on enormous file servers and linked together over the Internet. As John T. Bruer has cautioned in his well-timed book reviewing the literature on the brain, ***The Myth of the First Three Years***, care should be taken not to over generalize from the new brain data becoming available. However, as this science matures it will help clarify what the most effective strategies are for teaching specific disciplines, when they should be taught, and most importantly, what is the individual learning profile of each child. The learner profile will, in turn, guide instructional strategies for each child.

The data bases will ultimately contain the real-time records of millions of children and allow software providers to transition from being approximate in their instructional approach to a precise knowledge of what the child knows and how best to teach him or her. For example, ultimately there will be detailed records available of how millions of children have learned the letter “**A**.” Gradually researchers will build learner profiles that categorize how specific children learn the letter, what confuses them, and what instructional approach will best serve them given their unique learner profile. Researchers will be able to experiment overnight on testing differing instructional approaches for different learner profiles by assigning millions of children tasks that can be completed and compared in days instead of months or years. Testing will gradually be built into the instructional program so that student progress can be monitored in real time, not only at the end of a grade or term.

The breakthrough coming can be best categorized by defining its greatest contribution: providing additional resources that will add to the instruction currently

available to help educate children. The new technologies will be utilized to provide more instructional resources and allow education to substitute precision for approximation, be it in brain scans, teasing data out of giant data bases, or offering children the precise instruction they need whenever and wherever they might need it. Because energy sources will be doubling every two years, the ability to become more precise and knowledgeable in instructional sciences will be ever-increasing. Soon education will enter the realm all seek: the possibility of offering both equity and excellence in education to all the children on our planet.

PRESCHOOL IN THE HOME: A Case Study of the New Science of Education

A perfect blending of the five trends comprising the new science of education is the instruction of preschool children in their homes through programs funded by state legislators and the federal government. Here the new science of education has the capability of helping to solve the serious problem of having too many children entering kindergarten without adequate preliteracy training. The government will fund the movement because the cost/benefit ratio will be more favorable for this solution than any other alternative available as costs drop when the technology and software scale. This cost reduction cycle will contrast favorably with any alternative cycle devoid of technology that will unalterably continue to face inflationary costs associated with human labor and physical plant required by any program external to the home.

This program will have little impact on the universal preschool movement which is gradually gaining momentum throughout the states, or on Head Start or Early Head Start, which are full-service programs that meet social as well as academic needs. Parents desire these programs because they offer the convenience of providing day care as well as training their children in life and academic skills. The new technologies will supplement these programs by insuring academic skills are also learned by offering a home component for preschools. Where preschools are not yet available, the program will offer access to outstanding instruction for children at home. One unanticipated bonus from the home programs is that their costs will continue to decline to the point where they will be as little as 2 to 3% of the preschool costs, and the government and states who

are paying for the program will simply add to the preschool budgets to allow a universal home component for all children.

Without the use of the new generations of powerful educational software to support the preschool years, the American school system faces an almost unsolvable problem because too many of their students entering kindergarten are so ill- prepared that they face the prospect of are falling behind about a half of a grade level a year until they leave in droves dropping out between the 8th and 12th grades. The problem is exacerbated when students are concentrated in urban environments where as many as half or more will fail to graduate from high school.