Common Core State Standards for K-12 Education in America

David Moursund, Editor

Robert Sylwester, Editor

Although this is a complete and published book, it is also a work in progress. The last chapter contains brief introductions to a number of topics that could use more in-depth treatments. You may want to share your expertise in one of these or in other topics that would fit well into this book. If you would like to contribute a chapter, please contact David Moursund (moursund@uoregon.edu) or Robert Sylwester (bobsyl@uoregon.edu) with your ideas. We are interested in relatively short chapters—perhaps four to five pages in length. This book will be updated from time to time as new chapters become available.

The most recent version of this book is available for free download.

Microsoft Word: http://i-a-e.org/downloads/doc_download/249-common-core-state-standards-for-k-12-education-in-america.html.

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"Our greatest natural resource is the minds of our children." (Walt Disney; American film producer, animator, entertainer, international icon; 1901–1966.)

"Education must be increasingly concerned about the fullest development of all children and youth, and it will be the responsibility of the schools to seek learning conditions which will enable each individual to reach the highest level of learning possible." (Benjamin S. Bloom; American educational psychologist; 1913–1999.)

Front Matter

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David Moursund is an Emeritus Professor of Education at the University of Oregon. He earned his doctorate in mathematics from the University of Wisconsin-Madison. He taught in the Mathematics Department and Computing Center at Michigan State University for four years before joining the faculty at the University of Oregon.

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His professional career includes founding the International Society for Technology in Education (ISTE) in 1979, serving as ISTE's executive officer for 19 years, and establishing ISTE's flagship publication, *Learning and Leading with Technology*. He was the major professor or co-major professor for 82 doctoral students. He has presented hundreds of professional talks and workshops. He has authored or coauthored more than 60 academic books and hundreds of articles. Many of these books are available free online. See http://iae-pedia.org/David_Moursund_Books.

In 2007, Moursund founded Information Age Education (IAE), a non-profit company dedicated to improving teaching and learning by people of all ages throughout the world. See http://iae-pedia.org/Main_Page#IAE_in_a_Nutshell. For more information about David Moursund, see http://iae-pedia.org/David_Moursund.

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His most recent books are *A Child's Brain: The Need for Nurture* (2010, Corwin Press), *The Adolescent Brain: Reaching for Autonomy* (2007, Corwin Press; see an excerpt at http://www.sharpbrains.com/tags/robert-sylwester/), and *Creating an Appropriate 21st Century Education* (2012, Information Age Education).

He wrote a monthly column for the Internet journal *Brain Connection* during its entire 2000-2009 run (archived at http://brainconnection.positscience.com/library/?main=talkhome/columnists). He is a regular contributor to the *IAE Newsletter.*

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Information Age Education

Information Age Education (IAE) is a non-profit company in the state of Oregon that was established in 2007 by David Moursund. Its goal is to help improve worldwide informal and formal education at all levels. Its current list of free resources and activities includes:

- Free books published by IAE. See http://i-a-e.org/free-iae-books.html.

- Free IAE Newsletter published twice a month. See http://iae-pedia.org/IAE_Newsletter.
- IAE Blog. See http://iae-pedia.org/IAE_Blog.
- IAE-pedia. See http://iae-pedia.org/index.php?title=Special:PopularPages&limit=250&offset=0 for a list of pages ordered by popularity.
- Other IAE documents. See http://i-a-e.org/downloads.html.
- A major IAE initiative on math tutoring. See http://iae-pedia.org/Math_Tutoring_Project.

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Thanks to Ann Lathrop for her editing assistance.

"Pedagogy is what our species does best. We are teachers, and we want to teach while sitting around the campfire rather than being continually present during our offspring's trial-and-error experiences." (Michael S. Gazzaniga; American professor of psychology at the University of California; 1939–.)

Preface

All countries are concerned about the education of their people. With the resources each country is willing and able to devote to precollege education, each country works to develop an educational system that best serves the country and multiple stakeholders such as students, parents, teachers, local and regional populations, corporations, various ethnicity groups, various religious groups, and so on.

Each educational system is faced by a large number of potential goals. The combination of multiple stakeholders and multiple potential goals creates a unique and complex set of educational problems and opportunities for each country. It can also create considerable controversy. As noted by Woodrow Wilson, 28th President of the United States: "If you want to make enemies, try to change something."

This set of problems is made still more complex because of major changes occurring in our world. Science and technology are changing much more rapidly than a few decades ago. For example, we now have the Internet and the Web. We have made substantial progress in studying genomes, cognitive neuroscience, nanotechnology, and medicine. We have come to realize that our world faces problems of sustainability, global warming, pollution, hunger, disease, and over-population.

Thus, each country's educational system needs to "Think globally, act locally."

K-12 Education in the United States

The United States would like to have a world class K-12 educational system that meets the needs of students and other stakeholders. There is considerable evidence that our educational system could be considerably improved. Some of the evidence comes from international student assessments. However, much comes from the high drop-out rate of our students, the poor performance of many of our students on college placement tests in math and English Language Arts, performance in post secondary education, and the dissatisfaction of many employers with the educational level of newly hired employees.

The United States is in the midst of revising major parts of its K-12 school curriculum. The Common Core State Standards (CCSS) initiative began in the United States in 2010. Its initial emphasis on Math and English Language Arts has grown to include Science and History/Social Studies (CCSS, 2010 and 2012).

Recently Information Age Education has published a series of ten *IAE Newsletters* on CCSS. These ten newsletters have been integrated into the book you are now reading. The set of newsletters has been augmented by an Appendix, *Goals of Education in the United States.* This is a compendium that was first developed in 1988 and has been updated a number of times. All *IAE Newsletters* are available free at http://i-a-e.org/iae-newsletter.html.

The Mission Statement of the Common Core State Standards Initiative is:

> The Common Core State Standards provide a consistent, clear understanding of what [precollege] students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy (CCSS, 2010).

It is important to realize that a set of curriculum standards and a set of goals for education are two very different things. In some sense, a set of goals provides a foundation for education. A set of standards and details on implementing the standards is an attempt to turn foundational goals/ideas into practice.

This Is a Complete Book and also a Work in Progress

While integrating these ten newsletters into a short book, it became obvious that there are many important CCSS topics that are not covered. So the Editors have decided to try an experiment. Chapter 10 of the book contains a list of topics that could well become chapters in the book. We are seeking authors willing to write a chapter on one of these topics, or another relevant topic, for inclusion in this book. As new chapters are accepted for publication, they will be added to the book and new editions of the book will be made available on the Web.

Of course, we do not pay author royalties on this book. The book is distributed free on the Web. You can see a previous *IAE Newsletter*-based book, *Creating an Appropriate 21st Century Education,* at http://i-a-e.org/downloads/doc_download/243-creating-an-appropriate-21st-century-education.html. In the first seven months this book was available, it had over 6,500 downloads.

If you are interested in writing about one of the topics in Chapter 10 or a different topic you believe to be relevant, please contact David Moursund at moursund@uorgon.edu or Robert Sylwester at bobsyl@uoregon.edu. We look forward to hearing from you.

"One striking fact is that the complex world of education—unlike defense, health care, or industrial production—does not rest on a strong research base. In no other field are personal experience and ideology so frequently relied on to make policy choices, and in no other field is the research base so inadequate and little used." (*Improving Student Learning.* National Research Council, 1999.)

Chapter 1: Introduction to National Standards

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[IAE Newsletter #108. See http://i-a-e.org/newsletters/IAE-Newsletter-2013-108.html.]

CCSS is a state initiative. Quoting from the *Common Core States Standards Initiative* (http://www.corestandards.org/resources/frequently-asked-questions):

> The nation's governors and education commissioners, through their representative organizations the National Governors Association (NGA) and the Council of Chief State School Officers (CCSSO) led the development of the Common Core State Standards and continue to lead the initiative. Teachers, parents, school administrators and experts from across the country together with state leaders provided input into the development of the standards.
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> …
>
> States across the country collaborated with teachers, researchers, and leading experts to design and develop the Common Core State Standards. Each state independently made the decision to adopt the Common Core State Standards, beginning in 2010. The federal government was NOT involved in the development of the standards. Local teachers, principals, and superintendents lead the implementation of the Common Core (CCSS, 2010).

Educational Standards-based Education the United States

The United States does not have a centralized education system. In the U.S., each state is responsible for its own educational system and sets its own standards. However, the past two decades have witnessed a movement toward the development and implementation of national standards. Quoting from *Standards, Assessments, and Accountability*, a 2009 National Academy of Education Policy White Paper:

> Standards-based education reform [in the United States] has a more than 20-year history. A standards-based vision was enacted in federal law under the Clinton administration with the 1994 reauthorization of the Elementary and Secondary Education Act (ESEA) and carried forward under the Bush administration with the No Child Left Behind Act (NCLB) of 2001. In a recent survey of policy makers, standards were acknowledged as the central framework guiding state education policy.

> Yet, despite this apparent unanimity about the intuitively appealing idea of standards, there is great confusion about its operational meaning: exactly what should the standards be, how should they be set and by whom, and how should they be applied to ensure rigorous and high quality education for American students are the central questions that challenge policy makers and educators. For example, content standards (subject-matter descriptions of what students should know and be able to do) are often confused with performance standards (which are more like passing scores on a test), and very different theories of action are used to explain how standards-based reforms are expected to work. Ambitious rhetoric has called for systemic reform and profound changes in curriculum and assessments to enable higher levels of learning. In reality, however, implementation of standards has frequently resulted in a much more familiar policy of test-based accountability, whereby test items often become crude proxies for the standards. (See http://edweb.csus.edu/equity-center/assets/standards-assessments-accountability.pdf.)

Lifelong Learners

> "Try to learn something about everything and everything about something." (Thomas H. Huxley; English writer; 1825–1895.)

We are all lifelong learners. Our brain/mind is designed to receive information from our external and internal sensors, process the information, make use of or ignore it, and learn through this ongoing sequence of activities.

Thomas Huxley's statement suggests that a good education is quite broad, but includes depth in at least one area. One way to think about this is in terms of the broad general education that one needs to be a responsible and productive adult, and the depth of knowledge and skills one needs for a successful career.

I believe this was good advice when Huxley wrote it, and it is still good advice today. However, the totality of human knowledge has grown immensely over the past 150 years, and it is no longer possible to know something about everything or everything about something (Moursund, 2011b). Education is a complex and challenging discipline!

Here is one of my favorite quotes:

> "It takes a whole village to raise a child." (African proverb.)

Long before the development of reading and writing, children learned from their parents, siblings, and their "whole village." Children learned how to survive and prosper in their environment, to hunt and gather, make fire, shelter, and garments, prepare and preserve food, make and use tools, and so on. This learning came from a combination of imitation, explicit instruction, and trial and error. In some sense, education was a school of hard knocks.

A little more than ten thousand years ago, agriculture was developed. This led to increasing size of population centers, more specializations of work, and the need for record-keeping for use in business and government transactions.

Eventually, about five thousand years ago, reading and writing were developed. It takes an extended amount of formal instruction to learn reading and writing. Individual tutoring and early schools provided such formal education to a small percentage of the population. Most of the population remained illiterate.

The following quote gives us some insight into an early problem in formal education. People vary considerably in their natural learning-related cognitive abilities.

> "When you spoke of a nature gifted or not gifted in any respect, did you mean to say that one man may acquire a thing easily, another with difficulty; a little learning will lead the one to discover a great deal; whereas the other, after much study and application no sooner learns then he forgets …" (Plato; Classical Greek philosopher, mathematician, writer of philosophical dialogues, and founder of the Academy in Athens, the first institution of higher learning in the western world; 428/427 BC– 348/347 BC.)

Our current educational system still faces this challenge. As we work to set goals and standards in education, we need to hold firmly in mind the variability of students!

Meritocratic Civil Service

As populations increased and fiefdoms and countries developed, leaders needed able and educated assistants. These might be chosen from one's relatives, friends, and those swearing allegiance. As an alternative to this approach, China developed a merit system—civil servants chosen on the basis of their potentials as learners and workers.

Quoting from the Wikipedia:

> From the time of the Han Dynasty (206 BC to AD 220) until the implementation of the imperial examination system, most appointments in the imperial bureaucracy were based on recommendations from prominent aristocrats and local officials whilst recommended individuals were predominantly of aristocratic rank. Emperor Wu of Han started an early form of the imperial examinations, transitioning from inheritance and patronage to merit, in which local officials would select candidates to take part in an examination of the Confucian classics.
>
> The Chinese civil-service system gave the Chinese empire stability for more than 2,000 years and provided one of the major outlets for social mobility in Chinese society.
>
> The modern examination system for selecting civil service staff also indirectly evolved from the imperial one. This system was admired and then borrowed by European countries from the 16th century onward, and is now the model for most countries around the world. The first European power to successfully implement the meritocratic civil service was the British Empire, in their administration of India: "company managers hired and promoted employees based on competitive examinations in order to prevent corruption and favoritism." See http://en.wikipedia.org/wiki/Civil_service#Early_history.

Literacy

Over the centuries, leaders began to see the value of having a large number of citizens who had basic literacy. After the American Revolution (1776-1783) Thomas Jefferson noted the need for an educated and informed citizenry to help ensure freedom. In Virginia, he tried to persuade the Virginia Legislature to provide for free education up through the third grade. Although he was not successful in this endeavor, the attempt gives an indication of the level of education visionaries thought to be desirable for the general population at that time. In three years of schooling, students could achieve basic literacy and numeracy.

Literacy is a rather broad-reaching term. Quoting from the Wikipedia:

> Literacy is the ability to read for knowledge and interest, write coherently, and think critically about the written word. Visual literacy includes in addition the ability to understand all forms of communication, be it body language, pictures, maps, or video. Evolving definitions of literacy often include all the symbol systems relevant to a particular community. Literacy encompasses a complex set of abilities to understand and use the dominant symbol systems of a culture for personal and community development. In a technological society, the concept of literacy is expanding to include the media and electronic text, in addition to alphabetic and number systems. These abilities vary in different social and cultural contexts according to need and demand. (See http://en.wikipedia.org/wiki/Literacy#Ancient_and_medieval_literacy.)

This type of broad definition allows us to think about a student developing both general literacy and literacy within certain disciplines of study. For example, mathematics is a type of language. A person might have general skills in reading and writing, but be essentially illiterate in terms of the thinking, representing problems, and solving problems using the language of mathematics (Moursund, 2008).

Developers of a modern education system face some particularly difficult literacy challenges. For example:

1. Who should learn general reading and writing, and at what level of achievement? Nowadays there is considerable agreement that all children should earn to read. In the United States, the average adult reads at approximately the eighth grade level. That is, the average adult reads about as well as average students in our eighth grade. (See http://boards.straightdope.com/sdmb/showthread.php?t=166989.)
2. In the United States, a major goal in reading education is for students to be moderately skillful at reading to learn across curriculum areas by the end of the third grade, and that reading to learn across all school curriculum areas be a standard part of the instructional process by the seventh grade. (See http://www.ttms.org/content_area_reading/content_area_reading.htm.)
3. Information and Communication Technology (ICT) has spawned a new type of communication literacy including social networking, texting, email, audio, routine exchange of digital pictures and video, etc. This topic cuts across all curriculum areas and grade levels.
4. Computer-based information storage and retrieval systems have brought a world-class reference library to our fingertips. This library also includes computerized procedures that solve or help to solve a wide range of problems. This computational thinking and computer-assisted problem solving help to define a new type of communication literacy (Moursund, 2011a).
5. Interactive computer games and other digital forms of entertainment have overtaken television as a form of entertainment. Many students find these types of entertainment far more gripping (indeed, sometimes addictive) than traditional schooling (Moursund, 2013).

College and Career Readiness

College and career readiness is one of the current "buzz phrases" used in discussing goals for precollege education in the United States. See http://www.ed.gov/news/media-advisories/us-secretary-education-arne-duncan-visit-new-york-city-present-2012-broad-priz.

The buzz phrase uses the word *career* in place of *work* or *job.* In my mind there is a considerable difference between having a career and having a job. There are many minimal wage jobs that are easy entry, and require modest knowledge, skills, and on-the-job training or education. Many of these are "dead end" jobs. Today, there are fewer career-type jobs in which a person steadily gains in knowledge and skills and advances on the job at the same place of employment for a lifelong career.

There has been considerable research on how many hours of serious study and practice it takes a person to achieve a relatively high level of expertise in a specific career or avocation area. The most often quoted number is 10,000 hours. See http://en.wikipedia.org/wiki/Expert and http://blogs.scientificamerican.com/guest-blog/2011/06/06/too-hard-for-science-seeing-if-10000-hours-make-you-an-expert/.

Of course, there are many career-type occupations in which much of the needed learning can occur on the job and/or through a combination of a job-oriented education/training program of modest length and on-the-job experiences. I like to think of this as a type of schooling/apprenticeship type of preparation.

Multiple Career-type Jobs

You have probably heard statements predicting that the average adult will change careers six or seven times during his or her work career. See http://online.wsj.com/article/SB10001424052748704206804575468162805877990.html. When coupled with the many hours of study, training, education, and experience it takes to achieve a high level of expertise in a career area, this suggests that people who have a high level of expertise in a sequence of careers carry over considerable knowledge and skills from one career area to the next. Quoting Thorton May from her article "Why the Word 'Career' Has become Obsolete," we now "live in an age when the most important skill is the ability to acquire new skills.… Your career success is a function of how successfully you keep yourself upgraded." (May, 2012.)

May's article contains some history that you may find interesting:

> In the Middle Ages, one never heard the word career. Clerics in their monasteries (the first estate), kings in their courts (the second estate), and commoners in their mud huts (the third estate) didn't discuss career options.
>
> In much of early modern Europe, for most of recorded time, what one did occupationally (i.e., one's career) was essentially determined by birth. There was very little choice involved.
>
> The modern concept of a career originated in the mid to late 19^{th} century. The advent of the word career precisely coincides with the expansion of occupational choices. With improved agricultural methods, more food could be produced by fewer people, thereby allowing some subset of the people laboring in the fields to pursue other forms of employment. Technological innovations (like the steam engine) enabled new modes of production (e.g., factories) that expanded the work choices available.

Nowadays, both formal education (including college) and jobs/careers training are experiencing a relatively rapid pace of change. We want our precollege educational system to prepare students for this changing education and job/career world. We need to examine reform movements such as CCSS in light of how they will help to prepare students for this rapid pace of change.

References

CCSS (2010). *Common Core State Standards Initiative.* Retrieved 2/21/2013 from http://www.corestandards.org/the-standards.

May, T. (2012). Why the word 'career' has become obsolete. *Computerworld.* Retrieved 2/22/2013 from http://www.computerworld.com/s/article/9234728/Thornton_A._May_Why_the_word_career_has_become_obsolete.

Moursund, D. (2008). *Communicating in the language of mathematics.* IAE-pedia. Retrieved 2/21/2013 from http://iae-pedia.org/Communicating_in_the_Language_of_Mathematics.

Moursund, D. (2011a). *Computational thinking.* IAE-pedia. Retrieved 2/21/2013 from http://iae-pedia.org/Computational_Thinking.

Moursund, D. (2011b). *Information overload and underload.* IAE-pedia. Retrieved 2/21/2013 from http://iae-pedia.org/Information_Underload_and_Overload.

“When people cannot see the need for what’s being taught, they ignore it, reject it, or fail to assimilate it in any meaningful way. Conversely, when they have a need, then, if the resources for learning are available, people learn effectively and quickly.” (John Seely Brown, researcher in business innovation, and Paul Duguid, multidisciplinary researcher; from *The Social Life of Bees,* Harvard Business School Press, 2000.)

Chapter 2: Human Scale, Curiosity, and Technological Extensions

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[IAE Newsletter #100. See http://i-a-e.org/newsletters/IAE-Newsletter-2012-100.html.]

This chapter discusses the nature of humans as developers of tools to help satisfy their innate curiosity and needs. The focus is on what we can do without using tools or with using very simple tools versus what we can do with the more sophisticated tools such as GPS, smart phones, the Internet, and computerized games that now are all routine parts of our everyday lives.

Human Scale

Human scale is the level we humans function at only by very simple tools. It includes the cultural knowledge and understandings that get passed down through generations via play, parenting, and apprenticeship. Simple tools such as stone knives, fire, and spears were developed long before anatomically modern humans emerged about 200,000 years ago.

Unaided by more sophisticated tools, our human capabilities are limited. For example, at the human scale, we cannot see viruses or details of our moon’s surface, and our auditory range encompasses only about ten octaves. Many other creatures are faster and stronger than we are.

Although our body/brain is innately limited, we have immense curiosity. We have always been curious about what’s beyond our human ability range. We observed birds flying and fish swimming. We wondered about the immense sweep of the stars and the innards of insects. We continue to live comfortably within our human scale, but we have developed physical exercises, education, and technologies to push at our physical scale edges.

Children somehow sense their developmental limitations. Toddlers wish they could run. Preschoolers must ask their parents to read to them. Much childhood effort is focused on play that moves them towards observed adult capability. Young children are initially content to simply watch older siblings play video games, but soon they feel ready to play and want/expect a regular turn. They’re similarly willing to let their parents drive the car—until mid-adolescence.

Adults are fascinated by virtuosos who use dedicated effort to extend the normal human scale. The recent Olympics gathered many different virtuosos who entertained and astounded the observers. We cheered when someone extended a human performance range even ever so slightly.

We financially support individuals and groups who can play games or music at a virtuoso level, who can understand complex concepts, or who think more profound thoughts than the rest of us. We do love going beyond the edge, even vicariously.

Unfortunately, it would require greatly extended evolutionary time to develop the much more capable body/brain we would need to expand our normal biological range enough to satisfy our insatiable curiosity about what we cannot do. We have greater cognitive capabilities than all other animals, and we have used them to develop technological enhancements for both our brain and body.

Curiosity

Those who are quite comfortable with their current beliefs and a simple world are not very curious about alternate scientific explanations and new technological developments. Those who are momentarily thrilled by a new scientific/technological development tend to quickly shift their curiosity to what the next development might be. Both groups send their children to schools that are still largely a paper-and-pencil-driven institution in our increasingly electronic society.

At some ancient point humans developed the frontal lobe capability to technologically off-load tasks that required them to go well beyond the normal human scale. We contained fire to create energy, and cooked food helped to provide nourishment needed by an enlarged brain. Wheels eventually moved people, and wires moved information. We developed reading, writing, mathematics, and computers to help store and process information.

Our brain, formerly imprisoned within a limiting skull, has thus broken free and created a *technological brain* outside our skull that takes us well beyond human scale. Our curiosity-driven technology thus gives us an edge in natural selection (and a polluted environment for good measure).

Technology-Extended Scale

The recent technological explosion has allowed scientists to explore natural phenomena far beyond human scale. Most folks whose textbooks and teachers helped them learn about unseen atoms and molecules are now mystified by the differences between charm and bottom quarks. Higgs Boson discoveries seem wonderful, but are still incomprehensible to most of us. We now receive regular reports of the discovery of planets that circle suns located many light years from earth. We marvel over quasars, black holes, and quantum computers.

Well over one billion people across the age range are on various social computer networks today. More than two billion earthlings make use of the Internet (Phys.org, 1/26/2011). Such people must be concerned about viruses that cause human diseases and viruses that damage computer systems. Computers are getting smarter. Many people ask questions about how soon (if ever) robots will develop physical and mental capabilities that exceed those of humans (Sylwester & Moursund, 2012).

We remain biologically imbedded in our human scale even as science and technology sprint way beyond it. This causes cultural problems. Many people are psychologically committed to various ancient religious and philosophical explanations of natural phenomena that have been around so long that they have become part of the moral/ethical fabric of our cultures. In the competition for allegiance, the more-difficult-to-understand and constantly emerging scientific explanations and technologies are at a disadvantage, but a clear understanding of their applications is essential to a sound educational program.

Schools are expected to teach students current cultural knowledge, but educators now confront the problem of a rapidly widening gap between human scale explanations and scientific and technological developments—science driving technology. Scientific and technological advances formerly occurred at a relatively slower pace that allowed us to comfortably assimilate them. Current advances occur with a suddenness that can become culturally confusing.

School patrons who are fearful of a runaway science and technology tend to become even more committed to their human scale beliefs—a cultural-curricular disconnect. We're experiencing this in the Creationism controversy, sexuality education, global warming, and in the fear of what might happen to children searching an untrammeled Internet. Those on both ends of the continuum tend to be intolerant of the beliefs of the others about an appropriate education, and those in the center search for accommodation. Things won't become easier to sort out, since escalating genetic advances, cognitive neurosciences, and computer technology will pose a bewildering series of moral, ethical, legal, and cultural issues that students will have to be prepared to confront. The CCSS initiative must deal with such challenges.

A "Core" Education

The primary focus of this book is on the issues confronting the task of identifying core K-12 instructional issues. What do we want all students to learn during their formal K-12 education? What kinds of learning do we want families, the extended family, neighborhood, and community to informally foster? What roles should a student's parents and other caregivers play in deciding what a child is to learn through the combination of informal and formal education? How should it be taught and assessed? What roles should a school, school district, city, state, and nation play in deciding what children should learn and how they should learn it? How should this learning be assessed? How should our school expectations respect the individual differences among students?

As technology increases our physical and mental capabilities, how do we preserve and foster our human scale values and interpersonal knowledge and skills?

How have answers to these questions changed over time? Why do we need or want nationwide or statewide answers to the questions? How has the movement toward school district, state, and national standards helped and/or hurt our educational systems over the past hundred years or so?

Still, with all the current technological glitz, human scale remains important. Parents want their children to accurately spell and compute without the electronic support they themselves use. We supplement miraculous medical technology with bedside comfort. We flock to folk festivals. We expect our cultural heroes and political leaders to be ordinary as well as extraordinary. More than 2,400 years ago Protagoras said:

> "Man is the measure of all things." (Protagoras; pre-Greek philosopher; 490–420 BC.)

References

CCSS (2010). *Common Core State Standards Initiative.* Retrieved 10/25/2012 from http://www.corestandards.org/the-standards.

Phys.org (1/26/2011). *Number of Internet users worldwide reaches two billion.* Retrieved 10/25/2012 from http://phys.org/news/2011-01-internet-users-worldwide-billion.html.

Sylwester, R., & Moursund, D. (2012). *Creating an appropriate 21st century education.* Eugene, OR: Information Age Education. Free download available at http://i-a-e.org/downloads/doc_download/243-creating-an-appropriate-21st-century-education.html.

> "It isn't enough just to learn—one must learn how to learn, how to learn without classrooms, without teachers, without textbooks. Learn, in short, how to think and analyze and decide and discover and create." (Michael Bassis; American educator and author; 1946–.)

Chapter 3: Beginning the Search for an Appropriate Education

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We have created a dilemma that our curious brains currently confront. We now have wonderful technologies that take us far beyond our biological limitations. For example, U.S. pioneers moved at a basically human scale during their five-month wagon trip to the west coast—but a cross-country flight now takes only five hours. A complex football play that lasts a few incomprehensible seconds when viewed in real time becomes much clearer when viewed via several slowed-down multiple-angle instant televised replays explained by a knowledgeable announcer. Technology has thus allowed us to experience and better understand our world in ways far beyond our biological capabilities.

Early 20th century schools were confident that what they taught would probably survive and serve through a student's life. Folks accepted their stable curricular facts and cultural applications at face value—and they served reasonably well. However, much of today's science and technology will continue its exponential advancement beyond current levels throughout the lifetimes of current K-12 students.

The time of slow technological change is long past. As the totality of accumulated human knowledge continues its very rapid growth, 21st century schools are faced by major curricular and instructional challenges. Some of these challenges are directly based on science and technology, and others on the complexity of the cultural applications of rapidly changing science and technology.

Schools have historically sought to communicate cultural stability. Their new challenge will be to function effectively in an unstable cultural environment. Two basic proposed educational approaches follow.

From *Product* to *Process*

Product and process are central themes in education. This chapter expands these themes to the *understanding of product* and *understanding of process.* The understanding is needed both for transfer of learning and for building a foundation upon which to build more learning.

When science and technology remained reasonably stable, instruction and assessment could focus on knowing the product (the correct answer) rather than on understanding the cognitive processes that led to the answer. Often there was little emphasis on understanding the process that is the basis of the product.

The value of the product is often minimal in the total experience of an activity. For example, the final score is typically a small part of a game. Shortly after a game is over, the athletes start to think about the next game. Artists tend to sell the creations that occupied so a great deal of their time and creative energy. They want to get to the next challenge. A crossword puzzle that may have taken well over an hour to complete is immediately forgotten. The unscripted preparations for a wedding are more often recalled over the years than the scripted wedding itself. It is the process, not the product!

The situation becomes more complex when a process can be better carried out by various computerized technologies. Should students learn processes that can be rapidly, accurately, and cheaply carried out by computers? What about the creative process? We value the natural creativity of humans. How do we help people learn to integrate computer capabilities into their own creative thinking processes? Can a computer be creative? What types of creativity can a computer have or exhibit that a human does not, and vice versa?

Current times suggest that politicians and schools should back off their current obsession with product-oriented standards and assessment, and instead jump joyfully into the uncharted waters of exploration. It's nothing new. At least some European educators must have advised their students 500 years ago to get a ship and go west to discover what's over the horizon. More recently in the United States, Horace Greely advised:

> "Washington is not a place to live in. The rents are high, the food is bad, the dust is disgusting and the morals are deplorable. Go West, young man, go West and grow up with the country." (Horace Greeley; American author; 1811–1872).

We are now in a similar period of great exploration—but now we are exploring an immense outer space and a microscopic inner space.

Creative people and explorers don't want to be told the answer. They want to discover it. What facts should students memorize versus what facts should they learn to retrieve from reliable sources when they have need for the information? What should one discover for oneself, and how does this discovery process itself contribute to being able to discover things yet undreamed?

Where should we start in discussing such educational challenges? Collaborative classroom management has been around for a while, and it's an excellent initial area for teacher/student exploration of the processes involved in basic democratic values and skills. But why stop there? Many of the scientists and entrepreneurs who sparked our current creative explosion in science and technology were elementary students during the 1970's when such marvelous, imaginative, process-oriented programs as *The Elementary Science Study* and *The Science Curriculum Improvement Study* were in their heyday (see References). These programs created a wonderful open-ended process environment in which teachers and students explored together.

It accomplishes little to muse about how we subsequently got so untracked from this kind of K-12 process exploration. What is important now is that 21st century educators should take the position that an *educational product* that does not emerge out of an *exploratory process* is not worth assessing. It is appalling how much energy many schools currently spend on memorized preparations to meet politicized product standards. It is such a contradiction: a wealthy society that's very thankful for the creativity that sparked its wealth and scientific discoveries is now seemingly uninterested in developing even more creative folks. See Moursund (2010, 2011) for an extended discussion of recent research studies on the development of creativity.

From Clear to Complex Cultural Applications

It is one thing for a creative process to result in a new product. It is another thing to determine the cultural value and appropriate use of the product. And it's frequently difficult to achieve consensus on such issues. Nanotechnology, computer technology advances, cognitive neuroscience, and genetic engineering are but four examples of recent important developments that carry troublesome cultural baggage.

America is a country that espouses freedom of religion. How should our educational system handle controversies/conflicts between science and religion? This question is asked in many countries throughout the world. Evolution provides a specific example. Quoting the Wikipedia (http://en.wikipedia.org/wiki/Creation_and_evolution_in_public_education):

> Globally, evolution is taught in science courses with limited controversy, with the exception of a few areas of the United States and several Islamic fundamentalist countries. In the United States, the Supreme Court has ruled the teaching of creationism as science in public schools to be unconstitutional, irrespective of how it may be purveyed in theological or religious instruction. In the United States, intelligent design has been represented as an alternative explanation to evolution in recent decades, but its "demonstrably religious, cultural, and legal missions" have been ruled unconstitutional by lower courts.

Of course, the controversies extend far beyond theories of evolution. *The Values Clarification Movement* and *Man: A Course of Study* (see References) are two of several programs from several decades ago that sought to help elementary students responsibly explore difficult moral/ethical decisions. These and similar programs were vehemently criticized by folks who felt that schools should not help students explore the dynamics of solving complex cultural issues, but should rather teach students what to believe (generally the various belief systems of the critics).

This intense criticism stifled these and related programs designed to explore the complex issues that still confront us. These issues require both an understanding of science, technology, and culture—and the skills to responsibly reach consensus on developments and issues our society has never faced before. This ability doesn't magically emerge at age 18 in new voters. It has to be nurtured from the start.

The 21st century educators must thus respond also to this challenge, and discover ways to incorporate democratic decision-making skills into the entire K-12 curriculum. No simple solution exists to create human-scale solutions to scientific/technological developments that range way beyond our human scale, but educators might begin by examining innovative programs from several decades ago (such as those discussed above and cited in References) that sought to do what must be done now. Perhaps such programs arrived on the scene too early, but they or something like them are sorely needed today.

References

Man: A course of study. See http://en.wikipedia.org/wiki/Man:_A_Course_of_Study.

Moursund, D. (2010). *An intact human brain is naturally curious and creative.* IAE Blog. See http://i-a-e.org/iae-blog/an-intact-human-brain-is-naturally-curious-and-creative.html.

Moursund, D. (2011). *Declining level of student creativity.* IAE Blog. See http://i-a-e.org/iae-blog/declining-level-of-student-creativity.html

The Elementary Science Study. See http://www.nap.edu/openbook.php?record_id=4966&page=124.

The Science Curriculum Improvement Study. See http://american-education.org/1974-science-curriculum-improvement-study-scis.html.

The values clarification movement. See http://www.eric.ed.gov:80/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=EJ169012&ERICExtSearch_SearchType_0=no&accno=EJ169012

> "He who dares to teach must never cease to learn." (Adage, unattributed.)
>
> "A teacher affects eternity; he can never tell where his influence stops." (Henry B. Adams; American novelist, journalist, and historian; 1883–1918.)

Chapter 4: Science and Scholarship of Teaching and Learning

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The Science of Teaching and Learning, now more frequently called the Scholarship of Teaching and Learning (both abbreviated as SoTL) has a very long history (Moursund, 2012).

Think back many tens of thousands of years. A child growing up in a small clan or tribe learned the culture of the community along with survival skills such as hunting and gathering. This informal type of education sufficed.

As tools such as thrown spears and later bows and arrows were developed, children played with toys that introduced them to the tools. They observed and participated in the routine use of the tools by their older playmates, received hands-on instruction from adults, and learned by doing.

This type of hands-on learn-by-doing educational system began to change as agriculture supported the development of larger population centers, and specialists in the making and using of various tools emerged a little more than 10,000 years ago. In this type of environment, apprentices might spend years learning a specialization.

Reading and writing were developed little more than 5,000 years ago. The written language incorporated written symbols for numbers. Schools and formal schooling were established to teach reading, writing, and arithmetic. The art and craft of formal school teaching had begun.

Now, fast-forward still another 5,000 years to our present time. The art and craft of teaching and learning has improved significantly over these intervening years. Technological developments such as the printing press led to the mass production of print materials that greatly changed our world as formerly illiterate people gained access to books and learning. The continued development and accumulation of new knowledge and skills has accelerated the pace of change.

The art and craft of teaching and learning has recently morphed into the SoTL. Jacqueline Dewar and Curtis Bennett (2010) quote Ernest Boyer (1990) in "Situating SoTL within the Disciplines: Mathematics in the United States as a Case Study."

> Ernest Boyer (1990) introduced the phrase "scholarship of teaching" into the vocabulary of higher education in his book, *Scholarship Reconsidered.* He proposed that colleges and

universities needed a fresh vision of scholarship in order to tap the full range of faculty talents and to encourage vital connections between academic institutions and their local communities. He labeled and described four types of scholarship: discovery, application, integration and teaching, and he discussed some of the characteristics of what is now called SoTL, but did not offer a fully developed definition that included peer review and making results public. While similar concepts had previously been discussed (Cross, 1986) and later critical distinctions between scholarly teaching and the scholarship of teaching surfaced (Richlin, 1993, 2001, 2003), as President of the Carnegie Foundation for the Advancement of Teaching, Boyer brought national and international attention to SoTL.

We Are All Lifelong Learners and Teachers

I view all people as lifelong learners and teachers. Ongoing and lifelong learning are built into our physical and cognitive capabilities. Each of us learns as our brain processes new information from our senses and integrates this with information already stored in our brain.

In our every interaction with others, we function as both a teacher and a learner. This starts even before we are born. For example, an unborn child's brain becomes familiar with its mother's voice cadence and tonality. And, of course, you are familiar with the infant child teaching his or her parents and other caregivers, as they teach the child.

Over thousands of years, education practitioners and researchers have been improving the art, craft, science, and scholarship of teaching and learning to better fit the needs of students and the capabilities of teachers, and to take advantage of the many aids to teaching and learning that continue to be developed. The Common Core State Standards (CCSS) is the latest of major efforts to systematize curriculum content, teaching methodology, and assessment in key components of PK-12 education.

Students in our school systems learn content and learn to use their learning—but in the process also learn how to teach. Probably you have seen young children playing "school" and imitating teaching methodologies they have already learned from their own informal and formal schooling.

Today's Teacher Education Programs

By the time college students enter a teacher education program, they already know a great deal about teaching and learning from having participated in PK-12 and several years of college schooling. If the teaching they have received has been good, they already have made good progress toward eventually becoming effective teachers. Unfortunately, our teacher education programs face a difficult task when they must try to remediate students who have been poorly taught and/or have already learned ineffective methods of teaching and learning.

Many students enter teacher education programs with the goal of making PK-12 education better in the future than it was for them. In addition, today's preservice teachers face the difficult challenges of learning to incorporate all of the following into their teaching: newer methods of teaching; newer computer-technology; new developments in Information and Communication Technology (ICT); new aids to teaching and learning; recent progress in cognitive neuroscience; newer course content being developed based on new discoveries and inventions; and so on.

A final challenge is the fact that (1) our world, (2) preservice teachers in teacher education programs, (3) the faculty of teacher education programs, and (4) the precollege students the new teachers will be teaching, are all quite a bit different than they were a generation ago. One of the most important differences is the fact that many of today's students are much more computer-adept than either their teachers or the faculty that trained the teachers.

Academic Disciplines and Specialization

The steady accumulation of knowledge and skills over thousands of years has led us to an educational system that is divided into academic disciplines. Starting in kindergarten and continuing through high school, the study of disciplines such as language arts, math, science, social science, world languages, physical education, the arts, and so on tend to be separated from each other. In PK-12 education, one teacher may teach several of these disciplines and specialists may be used in others.

The breadth and depth of content in the various disciplines in the curriculum tend to overwhelm many preservice and beginning teachers. Many struggle to gain the knowledge and skills to be knowledgeable, creative, and flexible teachers for all the variety of disciplines they are responsible for teaching.

Each academic discipline or area of study can be defined by a combination of general ideas such as:

- The types of problems, tasks, and activities it addresses.
- Its accumulated accomplishments such as results, achievements, products, performances, scope, power, uses, impact on the societies of the world, and so on, and its methods of preserving and passing on these accomplishments to current and future generations.
- Its history, culture, and language, including notation and special vocabulary.
- Its lower-order and higher-order knowledge and skills, along with critical thinking and understanding.
- Its tools, methodologies, and types of evidence and arguments used to solve problems, accomplish tasks, and record and share accumulated results.
- Its methods of teaching, learning, and assessment.
- How one effectively teaches in a manner that preserves and sustains the discipline and passes it on to future generations.
- The knowledge and skills that separate and distinguish among: a) a novice; b) a person who has a personally useful level of competence; c) a reasonably competent person, employable in the discipline; d) an expert; and e) a world-class expert.

Discipline Specificity is a Major CCSS Challenge

Within a specific discipline, each of the bulleted items listed above can be an area of serious research, development, and other scholarly activity.

Undoubtedly you have heard about the idea of "viewing the world through rose-colored glasses." Think about the idea of viewing the world through the "eyes" of a specific discipline. A specialist in music learns to view the world through music-colored glasses. A specialist in psychology learns to view the world through psychology-colored glasses. An interdisciplinary researcher in science might learn to view the world through a combination of computer, math, and science-colored glasses.

In all cases, this "viewing the world" is based on learning to think, communicate, solve problems, and apply the knowledge and skills of the discipline. When students learn math in elementary school, we want them to learn some specific math topics and we also want them to learn to think in terms of this math as a way of viewing (dealing with) some of the problems and tasks they are encountering across the curriculum and outside of school, and will encounter in their adult lives.

Similarly, we don't simply want students to learn to read and write. We want them to learn to read and write across the discipline areas they are studying in school and learning about in life outside of school. We want them to master the transfer of learning to other disciplines they have studied, are studying, and will study. We want them to be able to transfer learning to novel problems and tasks they will encounter in the future. Every subject needs to be taught with transfer of learning in mind.

Information and Communication Technology (ICT)

For thousands of years, we have been well served by print, a static media. Even as we developed the telegraph, telephone, photography, recording and playback devices, radio, films, and television, these media have not been very interactive. However, computer technology has changed this. We now make routine use of media and other tools that have some semblance of intelligence. The machine intelligence is very different from human intelligence, but still is quite able to rapidly and accurately solve a wide variety of problems of interest to people and to carry out a large number of tasks for people. This automation of mental and physical tasks brings a new dimension to informal and formal education. It also brings major challenges to our educational system.

In closing, let me leave you with an important idea to mull over. Educators have long agreed that there are basics in educational content. They have agreed that students need to learn reading, writing, and arithmetic "across the curriculum." They recognize that transfer of learning is one of the most important ideas in education (Perkins & Salomon, 1992).

What educators have neither agreed on nor acted on is the idea of *ICTing* across the curriculum—thoroughly integrating the use of ICT as a routine component of curriculum content, instructional processes, and assessment that includes formative, summative, and residual input components. They have not agreed on the importance of the open computer, open connectivity approach to representing and solving problems that are now routine in the adult world of work and play. It is time to address these issues seriously and to be certain ICT is well integrated into the emerging CCSS.

References

Boyer, E. (1990). *Scholarship reconsidered: Priorities of the professoriate*. San Francisco: Jossey-Bass.

Dewar, J., & Bennett, C. (2010). *Situating SoTL within the disciplines: Mathematics in the United States as a casestudy.* Retrieved 10/29/2012 from http://academics.georgiasouthern.edu/ijsotl/v4n1/essays_about_sotl/_DewarBennett/index.html.

Moursund, D. (2012). *Scholarship/Science of Teaching and Learning*. IAE-pedia. Retrieved 2/12/2013 from http://iae-pedia.org/Scholarship/Science_of_Teaching_and_Learning.

Perkins, D., & Salomon, G. (1992). *Transfer of learning.* Contribution to the *International Encyclopedia of Education.* 2nd ed. Oxford: Pergamon. Retrieved 11/3/2012 from http://learnweb.harvard.edu/alps/thinking/docs/traencyn.pdf.

"It isn't enough just to learn—one must learn how to learn, how to learn without classrooms, without teachers, without textbooks. Learn, in short, how to think and analyze and decide and discover and create." (Michael Bassis; American educator and author; 1946–.)

Chapter 5: The Educational Challenge of Information and Communication Technology

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In this chapter, I use the term *Information and Communication Technology (ICT)* to cover the full scope of the discipline of Computer and Information Science, integration of computer applications to K-12 education, online education, computerized tools, calculators, and electronic games.

Reading, writing, math, and science are the four core disciplines included in the Common Core State Standards Initiative. See http://www.corestandards.org/the-standards.

Reading, writing, and math aid the human brain in addressing a very wide range of problems that people routinely encounter in their everyday lives. In the PK-12 curriculum, the reading, writing, and math content tends to be relatively stable over the years. For example, research in mathematics over the past century has had little impact on the PK-12 math curriculum.

Contrast this with our rapidly growing knowledge of science and the continuing challenge of bringing new scientific knowledge into the curriculum. *Science* is a catchall term, as there are a great many different science disciplines. In the United States, a high school graduate may have taken courses in earth science, biology, chemistry, and physics. All of these disciplines have seen major content growth in the past century, and some of this content is quite suitable for inclusion in the PK-12 curriculum.

Quite a bit of this research progress in the sciences in recent years has been helped—indeed, made possible—by computers, a discipline now usually referred to as Computer Science or Computer and Information Science. Thus, our precollege and higher educational systems face the challenge of integrating this new discipline of Computer Science and the steadily growing usefulness of computer-based tools in all of the sciences, as well as in all other academic disciplines across the curriculum.

Some History

Electronic digital computers started to become commercially available in the U.S. in the early 1950s. We have now had more than 60 years of rapid and continuing growth in the capabilities and availability of computers. Greater compute power has been coupled with a continuing decrease in the cost of this power. Nowadays, many computer games and "smart phones" have roughly as much compute power as did the multimillion-dollar super computers of about 25 years ago. The price to performance ratio of electronic digital computers has improved by a factor of well over a billion during the past 60 years. My desktop computer is more than a thousand times as powerful and only a thousandth of the cost of the one computer that served the entire University of Oregon when I joined its faculty in 1967.

Sometimes this progress is compared with progress in other areas. For example, can you imagine improving the gas mileage of a car from 25 miles per gallon to 25 billion miles per gallon?

Can you imagine improving the speed of an airplane from 250 miles per hour to 250 billion miles per hour? This far exceeds the speed of light. At that speed, a flight around the Earth would take well under a thousandth of a second!

The Early Days of Computer Science

The roots of Computer Science were developed well before the first electronic digital computer. The mathematical research work of Kurt Gödel (in 1931), Alan Turing (in 1936), and Alonzo Church (in 1936) provided a theoretical foundation for developing the discipline that eventually was named Computer Science or Computer and Information Science. See http://en.wikipedia.org/wiki/History_of_computer_science.

As computers became increasingly available in colleges and universities throughout the U.S., there soon became concentrations of computer courses and activity in Business Schools, Engineering Schools, and Departments of Mathematics. Business Schools were primarily interested in developing the use of computers to help solve business problems. Engineering schools were primarily interested in developing computer hardware. Mathematics departments were interested in using computers to help solve a wide range of applied math and statistics problems. And, of course, the military found a number of uses for computers—such as in the radar-equipped distant early warning systems.

Eventually Computer Science Departments were formed at many colleges and universities. Many were in the College of Arts and Sciences, but some were in the Engineering Schools. In the U.S., the first such department was formed at Purdue University in 1962 in the Division of Mathematical Sciences. It was a graduate program, offering the masters and doctoral degrees. See https://cs.uwaterloo.ca/~shallit/Courses/134/history.html.

Quite early on, it became clear that one did not need to be a genius to learn to write computer programs. The programming language BASIC became available in 1964. Although specifically designed for use in college and higher levels of education, it soon became evident that even grade school students could learn to use it to write simple computer programs. See http://en.wikipedia.org/wiki/BASIC. The programming language Logo became available in 1967; it was specifically designed for use in education. See http://en.wikipedia.org/wiki/Logo_%28programming_language%29.

And, of course, computer games were developed and "children of all ages" including adults enjoy playing them. Nowadays young children play many of these computer games even before they learn to read.

In 1972, the idea of Computer Literacy for all began to emerge based on the publications of Arthur Luehrmann (1972) and others as microcomputers came on the scene and spread rapidly into businesses, homes, and schools. See http://www.lcfarticles.com/articles/36/1/The-History-of-Microcomputers----Important-Date-Stones-1971--l981/Page1.html. Some historical notes about computer literacy are available in Moursund (2012).

Eventually microcomputers were equipped with word processing, database, spreadsheet, graphics, and other productivity tools that fit the needs of a very wide range of people. Students learned to make effective use of these computer tools with only a relatively little knowledge of the underlying computer science, hardware, and software. The focus on teaching computer programming in schools was gradually replaced by teaching students to use computer applications in various curriculum areas.

In the United States, the National Council of Supervisors of Mathematics and the National Council of Teachers of Mathematics first recommended the use of calculators and computers in school mathematics in 1979 and 1980. See http://darkwing.uoregon.edu/~moursund/Math/craft_and_science.htm. Although use of calculators is now permitted on many state and national exams, their routine use as accepted tools in many school classrooms remains controversial.

The steady improvement in the price to performance ratio of computers and calculators, their increasing availability, and their relative ease of use eventually led educators to consider a series of important questions:

1. In what ways should computers be routinely used by teachers for lesson preparation, student instruction, and record keeping?
2. In what ways should computers be used by students as an aid to learning?
3. When should calculators and computers be used by students to replace rote memorization and to help solve complex, challenging problem?
4. What should students be learning *about* computers as an aid to the human brain, and should they be learning to write their own computer programs?

Reading, Writing, Mathing, and ICTing Across the Curriculum

The initial development of written language and the teaching of reading, writing, and math based on written language occurred more than 5,000 years ago. Reading, writing, and math help with problem solving, accumulation of knowledge, and communication over time and distance.

It took many thousands of years before widespread elementary school education that included a strong focus on reading, writing, and math became common. It is only in the last century or so that it has become generally accepted that all children should gain basic knowledge and skills in these three areas. Even today, there are hundreds of millions of school-age children in our world who have little or no access to schools teaching these basic topics.

Each of these three areas of study has both breadth and depth. This is perhaps most obvious in math, where we now require students to take math year after year, with the content each year building upon the content of previous years. In the U.S., a major goal in reading and writing is for students to gain sufficient skill in these areas by the end of the third grade so much of their future learning can be based on this literacy. Reading as an aid to learning is a well-established part of each academic discipline.

Now, we have the rapidly evolving discipline of Information and Communication Technology (ICT). The technology is an important discipline in its own right and also a powerful aid to representing and solving problems, storing and retrieving information, and automating many mental and physical tasks in all areas of the curriculum. The Common Core State Standards initiative and other projects that seek to define the content, instructional processes, and assessment that make up the PK-12 school curriculum all face the problem of how best to integrate the power of ICT as an integral component of the content of each academic discipline.

Questions that need to be addressed include:

1. What ICT facilities should be made available to students for use in and outside of school?
2. What general ICT knowledge and skills should be specifically taught to all students?
3. What discipline-specific ICT-related content should be integrated into each school curriculum area?
4. What uses should be made of ICT by teachers for lesson development, instruction, and assessment?

My belief is that ICTing now ranks with reading, writing, and mathing as the four indispensible basics of a modern education. The goal should be for students to achieve a level of fluency, knowledge, and skills in each of these four areas that will appropriately serve them as they move on in their education and into productive and responsible adulthood in a world that will require lifelong education and adjustment to change.

Here are a few examples to illustrate what I mean by ICTing across the curriculum:

- For a number of years, each of the sciences has used theoretical, applied, and computational approaches to representing and solving problems (Moursund, 2011). Computer modeling, simulation, and problem solving are now important in every area of science.
- Reading and writing now take place in an ICT environment that includes video, audio, animation, graphics, social networking, the Internet, and the Web. Our traditional definition of reading/writing literacy now needs to be modified to include communication in this new ICT environment.
- The storage, communication, and retrieval of information is fundamental to every discipline. Thus, all students need basic knowledge and skills in information storage, processing, retrieval, evaluation, and use in our current and future Internet/Web world.
- Creative higher-order thinking, posing and solving problems, and accomplishing tasks are part of each academic discipline. Of course, the usefulness of computer tools varies considerably from discipline to discipline. For example, the computer tools used in composing, editing, and performing music are quite different from those needed in math and the sciences.
- Brain scientists, educational researchers, and curriculum developers are making good progress in the development of research-based Highly Interactive Intelligent Computer-Assisted Learning (HIICAL) and distance learning materials. It is important that all students learn to learn in these new ICT environments.

I like to look at such examples in terms of what a student might readily learn on his/her own, what all students should learn in their first few years of schooling, and the specific ICT-related knowledge and skills that should be integrated into the content of each discipline that students study as they progress through the grades.

Final Remarks

What **is** important is that we avoid having each teacher in each subject area forced to start from scratch in teaching ICT knowledge and skills to each new set of students they face. A third grade teacher needs to be able to assume that students already have an appropriate level of ICT knowledge and skills, in the same way that a third grade teacher can assume students have mastered appropriate levels of reading, writing, and math during their earlier years of schooling.

The need for and value of this vertically structured ICT curriculum as part of every PK-12 discipline area is a challenge to students, curriculum developers, teachers, and our assessment system. The next chapter explores ways the International Society for Technology in Education (ISTE) is effectively addressing these challenges.

References

Luehrmann, A. (1972). *Should the computer teach the student, or vice-versa?* Retrieved 11/20/2012 from http://www.citejournal.org/vol2/iss3/seminal/article2.cfm.

Moursund, D. (2011). *Computational thinking.* IAE-pedia. Retrieved 2/27/2013 from http://iae-pedia.org/Computational_Thinking.

Moursund, D. (2012). *Some history about computer literacy.* IAE-pedia. Retrieved 12/10/2012 from http://iae-pedia.org/Some_History_About_Computer_Literacy.

> "It is unworthy of excellent men to lose hours like slaves in the labor of calculation which could be safely relegated to anyone else if machines were used." (Gottfried Leibniz; German philosopher and mathematician; 1646–1716.)

Chapter 6: National Educational Technology Standards

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[IAE Newsletter #104. See http://i-a-e.org/newsletters/IAE-Newsletter-2012-104.html.]

International Society for Technology in Education

The International Society for Technology in Education (ISTE), based in Eugene, OR, is the leading professional society for Computers in Education in the United States. It began its work on developing National Educational Technology Standards for PK-12 students in the early 1990s.

In the interest of full disclosure, readers should be aware that I (David Moursund) founded ISTE in 1979 and headed the organization for 19 years. During this time, ISTE developed its first version of *ISTE National Educational Technology Standards for Students: 2007 profiles* **(**ISTE NETS•S, 2007). Dr. Lajeane Thomas of Louisiana Tech University headed the standards development project.

> First introduced in 1998, the National Educational Technology Standards (NETS) Project is an ongoing initiative of the International Society for Technology in Education. In a unique partnership with teachers and teacher educators, curriculum and education associations, government, businesses, and private foundations, ISTE has responded to calls for educational technology standards, curriculum, and tools with its NETS Project. The primary goal of the NETS Project is to enable stakeholders in PK–12 education to develop national standards for educational uses of technology that facilitate school improvement. The NETS Project works to define standards for students, integrating curriculum, technology, and standards for student assessment and evaluation of technology use. Forty-nine of the 50 U.S. states have adopted, adapted, or referenced ISTE's NETS in state department of education documents. See http://www.iste.org/store/product?ID=479.

The ISTE Standards for Students Project developed six general categories of desirable student knowledge and skills in Information and Communication Technology (ICT). Quoting from http://en.wikipedia.org/wiki/National_Educational_Technology_Standards (Wikipedia, n.d.) these categories are:

a. **Creativity and Innovation:** Using creative thinking and innovative technology the students demonstrate and develop models and simulations to explore and identify complex systems and forecast possibilities as well as they use existing knowledge to generate new ideas and creative thoughts.

b. Communication and Collaboration: Students use digital media and environments to collaborate, communicate, and interact with other students, teachers, and professionals. They also engage in a cultural and global awareness and contribute to project teams to produce original works or solve problems.

c. **Research and Information Fluency:** Students apply digital tools to plan, organize, and gather information, in order to be able to inquire, analyze, organize, and evaluate information.

d. **Critical Thinking, Problem Solving, and Decision Making:** Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

e. **Digital Citizenship:** Students demonstrate personal development to be life long learners because they are aware of the human, cultural and social issues related to technology and they practice ethical and legal digital behavior.

f. **Technology Operations and Concepts:** Students demonstrate a sound understanding of technology concepts, systems, and operations so they are able to select, transfer, understand and troubleshoot various systems and applications productively and effectively.

Notice the generality of statements a-f. There is no mention of specific hardware or software, types of problems to be solved, academic disciplines, or grade levels. There is little indication of how one might go about helping students to learn these general concepts or how student knowledge and skills might be assessed.

These are intentionally broad, general statements designed as a basis for future discussion and action. A somewhat more detailed version of this list is available at http://www.claco.com/Mr.PF/portfolio/ISTE-Standards/NETS-for-Student/508787422f772100020010a1.

The next step was the development of more detailed recommendations for students in grade levels PK-2, 3-5, 6-8, and 9-12. ISTE did this by giving examples of learning activities suitable for each of the various grade-level bands. To illustrate, learning activities for grades 6-8 (ages 11-14) are given below. The letters in parentheses indicate the general categories of each of the activities. Quoting from (ISTE NETS•S, 2007):

Grades 6-8 (ages 11-14):

1. Describe and illustrate a content-related concept or process using a model, simulation, or concept-mapping software. (a,b)
2. Create original animations or videos documenting school, community, or local events. (a,b,f)
3. Gather data, examine patterns, and apply information for decision making using digital tools and resources. (a,d)
4. Participate in a cooperative learning project in an online learning community. (b)
5. Evaluate digital resources to determine the credibility of the author and publisher and the timeliness and accuracy of the content. (c)

6. Employ data-collection technology, such as probes, handheld devices, and geographic mapping systems, to gather, view, analyze, and report results for content-related problems. (c,d,f)
7. Select and use the appropriate tools and digital resources to accomplish a variety of tasks and to solve problems. (c,d,f)
8. Use collaborative electronic authoring tools to explore common curriculum content from multicultural perspectives with other learners. (b,c,d,e)
9. Integrate a variety of file types to create and illustrate a document or presentation. (a,f)
10. Independently develop and apply strategies for identifying and solving routine hardware and software problems. (d,f)

This level of detail is still loaded with implementation difficulties for curriculum developers. You can gain some insight into this by examining one section: *d. Critical Thinking, Problem Solving, and Decision Making* from each of the grade-level bands. Here are the recommended standards in two grade-level bands.

Grades PK-2: ***d. Critical Thinking, Problem Solving, and Decision Making***

- Identify, research, and collect data on an environmental issue using digital resources and propose a developmentally appropriate solution.
- Use simulations and graphical organizers to explore and depict patterns of growth, such as the life cycles of plants and animals.
- Independently apply digital tools and resources to address a variety of tasks and problems.

Grades 3-5: ***d. Critical Thinking, Problem Solving, and Decision Making***

- Produce a media-rich digital story about a significant local event based on first-person interviews.
- Recognize bias in digital resources while researching an environmental issue with guidance from the teacher.
- Select and apply digital tools to collect, organize, and analyze data to evaluate theories or test hypotheses.
- Conduct science experiments using digital instruments and measurement devices.
- Conceptualize, guide, and manage individual or group learning projects using digital planning tools with teacher support.
- Apply previous knowledge of digital technology operations to analyze and solve current hardware and software problems.

These standards for students also illustrate the depth and breadth of ICT knowledge and skills that their teachers need to have in order to effectively implement the problem-solving component of NETS•S.

ISTE has published a number of books that provide considerable more detail about the NETS for students and about the knowledge and skills teachers must develop to implement these standards (ISTE, 2013).

Teacher Education

From the very beginning of the ISTE Standards project, there was full awareness of the staff development needed to enable teachers to comfortably implement the ISTE Standards. The U.S. Department of Education recognized these difficulties. Beginning in 1999, the Preparing Tomorrow's Teachers to Use Technology program provided one-year start up grants and three-year implementation grants to hundreds of teacher education programs across the U.S. See http://www2.ed.gov/programs/teachtech/index.html.

For years, ISTE has included a strong focus on teacher education in its annual conference sessions, workshops, and webinars. In addition, ISTE has developed National Educational Technology Standards (NETS) and supportive materials for educators:

- NETS for Teachers: The standards for evaluating the skills and knowledge educators need to teach, work, and learn in an increasingly connected global and digital society.
- NETS for Administrators: The standards for evaluating the skills and knowledge school administrators and leaders need to support digital age learning, implement technology, and transform the instruction landscape.
- NETS for Coaches: The skills and knowledge technology coaches need to support peers in becoming digital educators.
- NETS for Computer Science Educators: The skills and knowledge that computer science educators need to reach, inspire, and teach students in computing. See http://www.iste.org/STANDARDS.

Currently ISTE serves as one of the 22 national organizations charged with developing the standards that the National Council for Accreditation of Teacher Education (NCATE) uses to accredit Colleges of Education throughout the U.S. See http://www.ncate.org/MemberOrganizations/tabid/588/Default.aspx?ch=121&QID=4.

Final Remarks

ICTing Across the Curriculum remains a challenging and fast moving target. Our current educational system is not designed to deal with the pace of change that ICT brings to our students' world of schooling, work, play, and learning to become a responsible adult citizen.

The strong and forward-looking leadership of ISTE's work in this field has been insightful and helpful. However, the challenge far transcends what one professional society can do alone. The professional association(s) of each academic discipline must fully accept the need to educate its practitioners in the uses of ICT to help students both to represent and to learn to solve the problems and accomplish the tasks that define their discipline. The school curriculum in each discipline area needs to fully integrate ICT into the content, teaching processes, and assessment of their discipline.

In this context, CCSS must carefully evaluate the rapidly changing nature, abilities, and interests of today's students who have grown up in an ICT-rich environment. Their approaches to communication, entertainment, learning, and problem solving are vastly different from those of their teachers and parents. See http://i-a-e.org/myblog-admin/a-new-kind-of-learner.html. We as educators must be fully aware of, and prepared to adapt education in response to, these differences.

References

ISTE (2013). ISTE books about NETS. ISTE bookstore. Retrieved 11/25/2012 from http://www.iste.org/store/books-courseware/all-books.

ISTE NETS•S (2007). *ISTE National Educational Technology Standards for Students: 2007 profiles.* Retrieved 11/23/2012 from http://www.iste.org/standards/nets-for-students/nets-for-students-2007-profiles.

Wikipedia (n.d.). *NETS for students.* Retrieved 11/23/2012 from http://en.wikipedia.org/wiki/National_Educational_Technology_Standards -NETS_for_Students.

> "Learning without thinking is labor lost; thinking without learning is dangerous." (Chinese proverb.)
>
> "Education is the key to unlock the golden door of freedom." (George Washington Carver; American freed slave, scientist, botanist, inventor, and educator; 1864–1943.)

Chapter 7: Some General CCSS Considerations

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[IAE Newsletter #105. See http://i-a-e.org/newsletters/IAE-Newsletter-2013-105.html.]

This chapter provides a general overview of the Common Core State Standards (CCSS). The website www.corestandards.org includes complete specific grade level emphases, and the other websites in the References section below add additional useful information.

The CCSS is often mistaken as an initiative of the federal government, but the Council of Chief State School Officers (CCSSO) and the National Governors Association Center for Best Practices (NGA) began the movement, with input from K-12 educators. In the previous system of individual state standards, test results in one state could have identified certain students as being proficient in a tested area. The students could subsequently move to another state and be categorized there as being below proficiency in that area. Many felt that this system of differential state standards probably needed to be changed, if standardized tests were going to be continually used to determine K-12 subject proficiency.

Those involved in the CCSS initiative examined college levels of rigor and complexity, and found significant discrepancies compared to high school expectations. The CCSS groups then sought to insure that students gradually worked up to expected collegiate beginning levels. Further, the amount and complexity of information that is increasing at a rate we never before experienced also suggested that K-12 students must go far beyond merely accumulating knowledge. They also must be challenged to think critically with higher-order thinking skills that emphasize depth, complexity, and application.

According to the CCSS initiative:

> As specified by CCSSO and NGA, the Standards are (1) research and evidence based, (2) aligned with college and work expectations, (3) rigorous, and (4) internationally benchmarked. A particular standard was included in the document only when the best available evidence indicated that its mastery was essential for college and career readiness in a twenty-first-century, globally competitive society. The Standards are intended to be a living work: as new and better evidence emerges, the Standards will be revised accordingly (CCSS, 2010).

Focus and Timeline

The CCSS released the College and Career Readiness Standards in the summer of 2009, followed by the June 2010 Standards for English Language Arts and Mathematics. The Next

Generation Science Standards were opened for comment on January 8, 2013. See http://www.nextgenscience.org/next-generation-science-standards. CCSS standards for History are still a work in progress. Assessments should be in place for the 2014-2015 academic year, and materials should be approved by 2016.

The College and Career Readiness anchor standards are consistent, broad-based expectations infused into all grade levels and subject areas. These emphasize skills considered necessary in both college and work environments.

Attention to 21st century skills is an important factor in the new CCSS. Communication, collaboration, critical thinking, and creativity are among the skills required to be successful in the world of the 21st century.

The **CCSS for English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects** have three main sections. Those for K-5 are comprehensive, while those for 6-12 are divided into an English Language Arts (ELA) section and a section each for history/social studies, science, and technical subjects. These are organized into strands, with K-5 and 6-12 ELA emphasizing Reading, Writing, Speaking and Listening, and Language, and with 6-12 history/social studies, science, and technical subjects emphasizing Reading and Writing. Each strand has a strand-specific set of College and Career Readiness Anchor Standards. Each broad CCR anchor standard has an accompanying grade-specific standard, which translates into grade-appropriate expectations.

It is noteworthy that these literacy skills should also be applied outside the area of English Language Arts. The emphasis here is on literacy and this should not be confused with standards for the *content* in these areas. In a move toward shared responsibility, teachers outside of the formal arena of English Language Arts must now also be responsible for literacy. Dealing with text takes on an increasingly important role, with a transitional emphasis in reading toward informational text and in writing toward argument and informational/explanatory text. Three appendices provide further information, clarification, and detail.

The **CCSS for Mathematics** are organized into domains, clusters, and standards that are intended to move away from the broad and shallow approach of current curricula to an emphasis on mastery of topics through procedural fluency and conceptual understanding. K-8 standards are organized by grade level and high school standards are organized within six conceptual categories: Number and Quantity, Algebra, Functions, Modeling, Geometry, Statistics and Probability. There is an increased focus of content within grade levels, and an increased coherence of content from grade-to-grade. A significant additional change is that, in addition to the standards for content, there are also standards for mathematical practice, emphasizing factors such as making sense of problems and perseverance in solving them, abstract and quantitative reasoning, mathematical modeling, using appropriate tools strategically, attending to precision, looking for and making sense of structure, and looking for and expressing regularity in repeated reasoning.

Assessment

Formal assessments using the CCSS are scheduled to begin with the 2014-2015 academic year. Two different groups have been charged with the task of creating these assessments: the Smarter Balanced Assessment Consortium (SBAC; http://www.smarterbalanced.org/) for roughly half of the states and the Partnership for the Assessment of Readiness for College and Career (PARCC; http://www.parcconline.org/) for the rest. Part of the assessments will be technology-administered and will include free-response items. There will be options for formative assessments to be administered at times throughout the year. The computer-based portion of the SBAC assessment will be adaptive; students who answer a question correctly will get more challenging questions, and those who answer incorrectly will get simpler subsequent questions.

A paper and pencil version of the test should be available for a period of time. There is speculation and discussion that students and schools using this version should perhaps be penalized by one percentile point.

The assessments will comprise the following types of items: Selected Response Items (SR), Constructed Response Items (CR), Technology Enhanced Items/Tasks (TE), and Performance Tasks (PT).

- Selected Response refers to what is commonly called multiple choice.
- The more complex Constructed Response requires students to develop personal answers without suggested choices. Students produce a text or numerical response in order to gather evidence about their knowledge/understanding of a given assessment target.
- Technology Enhanced Items/Tasks use computer-based administration to assess a deeper understanding of content and skills than would otherwise be possible with traditional item types. Technology enhanced items use technology to collect evidence through a non-traditional response type, such as editing text or drawing an object.
- Performance Tasks are intended to measure a student's ability to integrate knowledge and skills across multiple standards—a key component of college and career readiness. Performance tasks measure such capabilities as depth of understanding, research skills, and complex analysis, which cannot be adequately assessed with selected or constructed response items.
    - English Language Arts – Performance Tasks for English Language Arts will focus on reading, writing, speaking and listening, and research claims. They measure capacities such as depth of understanding, interpretive and analytical ability, basic recall, synthesis, and research.
    - Mathematics – Performance Tasks for Math will integrate knowledge and skills across multiple claims, measure capacities such as depth of understanding, research skills, and/or complex analysis with relevant evidence. These tasks require student-initiated planning, management of information/data and ideas, and/or interaction with other materials. They will also reflect real-world tasks and/or scenario-based problems, allow for multiple approaches, represent content that is relevant and meaningful to students, allow for demonstration of important knowledge and skills, require scoring that focuses on the essence of the claim(s) for which the task was written, and seem feasible for the school/classroom environment. Mathematical modeling and application are emphasized.

In the development of these standards, some developers were understandably concerned about existing excess standardization, and others felt that states needed to have some leeway to include information that could be state specific. Every state, therefore, was allowed to supplement the national CCSS by up to 15%.

In many ways, the CCSS and their implementation are a work in progress and will evolve as more evidence and information become available. According to the CCSS initiative,

> These Standards are not intended to be new names for old ways of doing business. They are a call to take the next step. It is time for states to work together to build on lessons learned from two decades of standards based reforms. It is time to recognize that standards are not just promises to our children, but promises we intend to keep (CCSS, 2010).

References

Suggestion: Please visit the website of your respective State Department of Education.

Achieve. Retrieved 1/13/2013 from http://www.achieve.org/.

CCSS (2010). *Common Core State Standards Initiative.* Retrieved 2/21/2013 from http://www.corestandards.org/the-standards.

College and career readiness. Retrieved 1/13/2013 from http://www.collegecareerready.org.

Next Generation Science Standards. Retrieved 1/13/2013 from http://www.nextgenscience.org/.

PARCC: Partnership for assessment of readiness for college and careers. Retrieved 1/13/2013 from http:// www.parcconline.org.

SBAC: Smarter Balanced Assessment Consortium. Retrieved 2/23/2013 from http://www.smarterbalanced.org/.

"The most dangerous experiment we can conduct with our children is to keep schooling the same at a time when every other aspect of our society is dramatically changing." (Chris Dede; American computer educator and futurist; from written statement to the PCAST panel, 1997.)

Chapter 8: Getting to the Core Issues—Will We Get It Right?

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[IAE Newsletter #106. See http://i-a-e.org/newsletters/IAE-Newsletter-2013-106.html.]

The Common Core State Standards (CCSS) have enthusiastic proponents and harsh critics. This chapter provides some considerations about how the CCSS can best serve their intended purpose: To help ensure K-12 student mastery of the central curricular components they will need to succeed in college, careers, and other aspects of their adult lives.

Hitting the Target, But Missing the Mark

Suppose you want to quickly lose or gain 10 pounds. Certain drugs, exercise, and a controlled low calorie diet can help you lose weight, while certain other drugs, a controlled high calorie diet, and weight gain supplements can help you gain weight. The problem with either plan is that it could possibly leave your health worse off than it was, and the weight changes are not apt to be long lasting. You also could be at risk for immune, cardiac, and other disorders.

Professionals in this field know of better ways to reach and maintain weight loss/gain goals. They would probably begin by asking two questions: "Why do you need a weight change goal?" and "What's the best way to accomplish it?"

The CCSS movement confronts an analogous issue. How best can we (quickly) improve K-12 education in a manner that will be sustained and will have few undesirable side effects? Over the years, individual state standards and Federal pressures have shifted the concepts of curriculum and instruction to a new emphasis on curriculum and assessment. States' testing programs focused on what students were supposed to learn, but didn't address the underlying issues of why and how they were supposed to learn it. The CCSS developers are trying to address these weighty why and how questions. This article will suggest elements of the CCSS program that provide promise and elements that perhaps should cause concern.

A Few Perspectives from Within and Without the Field

Support for and opposition to the CCSS come at macro and micro levels. Macro level detractors object to the basic premise of needing a single set of standards in our diverse and changing world. They tend to prefer "local" over national control. They also argue that our current educational system is not as badly flawed as many claim. Conversely, supporters of the CCSS believe that a national set of internationally benchmarked expectations offers a potential solution to the educational and career woes that plague our educational system.

Some Potential Positives of the CCSS

Many CCSS supporters state that an important strength is the fact that carefully selected standards can build upon one another and emphasize critical thinking, depth and complexity, Partnership for 21st Century Skills (1/13/2013), College and Career Readiness (1/13/2013), and international benchmarking. In our highly mobile society, students moving from one state to another would make a more seamless transition. The CCSS also place considerable emphasis on better and more uniform assessment.

The CCSS already are having a major impact on school textbook publishers. In a practical sense, the CCSS may likely allow opportunities for publishers of educational materials to focus their resources on higher quality products instead of continuing to modify content to meet the needs of individual state curricula.

Greater uniformity in content and assessment will make it easier for people who provide free materials via the Web to develop materials with potential nationwide usefulness. This kind of educational collaboration can help to improve the quality of classroom instruction.

Individual states will still have some degree of flexibility in adapting the CCSS to meet state needs and/or demands. Many educators already embrace the CCSS focus on higher-order thinking skills, depth of knowledge, critical thinking, and performance. They see this as a very positive move away from the currently prevalent drill and kill practices.

The English Language Arts College and Career Anchor Standards, if correctly put into authentic play, can help the new generation of K-12 learners to be better prepared for college, career, and life. See http://www.corestandards.org/ELA-Literacy/CCRA/L. The English Language Arts CCSS place a greater emphasis on non-fiction text, and they stress the importance of reading across the curriculum. Many people feel the increased emphasis on such reading, along with using reading as a vehicle for learning the various disciplines, will contribute to student success in college, careers, and life.

Some Potential Negatives of the CCSS

Claims that certain individual state's standards may be superior, suspicions about a "national" curriculum (perhaps blurring "federal" with "national"), and preferences for local control are among some of the overarching criticisms. They point to very large differences in the culture and life in different parts of the country, and argue that schools need to accommodate and support such diversity.

Many critics are displeased with the strong emphasis on algebra and claim there is a lack of emphasis on math facts, basic arithmetic, and algorithms during the elementary school years.

Timing may be another issue. Teachers are expected to begin using the CCSS while the corresponding assessments are still being developed. This leaves a potential gap between what is being taught and what is being assessed. This could lead to considerable confusion and frustration.

A high fidelity of implementation will require far more staff development than is currently available. With the current state of the economy, and with human and financial resources stretched, many see the implementation of the CCSS as a monumental and expensive task, one that poses a significant challenge. School systems have limited budgets to provide needed training to familiarize teachers and other stakeholders with the CCSS content and the effective delivery of that content.

In recent years, assessment and accountability have become a central practical feature of the implementation of the state standards, resulting in what amounts to checklists of items that had to be covered rather than emphasizing the quality of learning and teaching. Educators perhaps need to proceed with the spirit and not merely the content of the CCSS in order to avoid the potential pitfalls of "business as usual." When overly stressed, we tend to take the path of least resistance.

The Bored of Education: The Brain that Wouldn't Go Away

Learning does not occur in a vacuum. Among the many forces at play are physiological, psychological, social, cognitive, behavioral, verbal/non-verbal, explicit and implicit communication, and others. Ignoring or overlooking these forces reflects a fundamental misunderstanding of real learning—that it somehow can or will occur or exist independent of these and other factors.

Revisions to curriculum content and assessment may have little impact on student in-school attention, learning, and comprehension. The planned revisions may even increase the growing mismatch between our Information Age children who routinely and fluently make use of many aspects of Information and Communication Technology, and their schooling experiences.

The good news is that we now know enough to start to make major improvements in our educational system. Professionally driven 21st century teachers must master educationally significant cognitive neuroscience discoveries, and work to apply them appropriately in their teaching. Our profession must reach beyond the confines of the field itself to learn the valuable and essential lessons that will make the difference in our schools. When we do, student interest and achievement will increase and misbehavior will decrease.

Final Remarks

Suppose I were to ask two different people if they had been to Yosemite National Park, and one had driven through with the car windows shut and never stopped, while the other had parked, gotten out, hiked, touched, smelled, and experienced the park. Both could technically say they had been there. Their experiences, however, would have been dramatically different. To truly appreciate the majesty and grandeur of Yosemite, one must be interested enough to explore and truly experience it in a variety of ways.

Real learning is similar. Plowing through curriculum is a very different experience from meaningfully exploring, analyzing, using, synthesizing, and extending information and understanding in the quest for true learning. In both cases, however, the curriculum has been "covered." Large philosophical questions notwithstanding, the CCSS and their associated assessment systems in and of themselves likely are neither inherently good nor bad.

Like all standards and curricula, the CCSS have their definite strengths and weaknesses. As states move toward full implementation, educators need to know and use not only the CCSS themselves, but also the "Why" and the "How" of education. These are the very factors that would help influence a brain to attend and a student to really learn to be a creative and innovative problem-solver in a rapidly changing world.

Educators can and do make a difference. Those who understand the brain and learning, and the implications and applications of this knowledge, will be in a better position to teach and facilitate learning that can inspire generations of students to come.

Information Resources

Some salient points that might interest you are modified within a blog that I wrote for the American Planning Association. See http://blogs.planning.org/kids/2012/01/06/space-matters-engaging-the-brain/.

ASCD. *Common Core: 7 Recommendations for effective implementation.* See http://thejournal.com/articles/2012/11/01/common-core-7-recommendations-for-effective-implementation.aspx?admgarea=News1.

ASCD. *Smartbrief. Common Core guide: Students should read more of everything.* See http://www.smartbrief.com/servlet/encodeServlet?issueid=B483129B-F8DA-4AE4-AAD4-92FCFC38A8B2&sid=f0bb33a31-9171-4453-bc8d-d942386e1ee8.

CCSS (2012). *Statements of support.* See http://www.corestandards.org/about-the-standards/statements-of-support.

College and career readiness. Retrieved 1/13/2013 from http://www.collegecareerready.org.

Education Next. The war against the Common Core. See http://educationnext.org/the-war-against-the-common-core/.

Partnership for 21st century skills. Retrieved 1/13/2013 from http://ww(n.d/). w.p21.org.

The Atlantic. A new kind of problem: The Common Core Math Standards. See http://www.theatlantic.com/national/archive/2012/11/a-new-kind-of-problem-the-common-core-math-standards/265444/.

"You don't just learn knowledge; you have to create it. Get in the driver's seat, don't just be a passenger. You have to contribute to it or you don't understand it." (W. Edwards Deming; American international business consultant and statistician; 1900–1993.)

"Education is not a preparation for life; education is life itself." (John Dewey; American philosopher, psychologist, and educational reformer; 1859–1952.)

Chapter 9: The Emerging Picture of Natural Learning, and the Implications for Dealing with the Common Core State Standards

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[IAE Newsletter #107. See http://i-a-e.org/newsletters/IAE-Newsletter-2013-107.html.]

Neuroscience has indeed helped put an end to the deeply engrained belief that students are little more than empty vessels waiting to be filled. But has this news transformed or changed how we educate? Other than using brain-based "strategies that work," have educators grasped what Antonia Damasio means when he refers to the human being as an indissociable human organism where body, emotions, and brain/mind continuously interact (Damasio, 1994)?

How can we possibly reconcile what is now known about the integrated nature of human learning with a top-down model of a standards-based curriculum tied to content testing? How can the current system of education, deeply steeped in a culture of compliance, possibly engage in something that mirrors the complexity and power of the human brain and body?

Despite continuous and well-intentioned efforts to refine standards, they remain embedded in what biologist Richard Dawkins call a "meme." See http://en.wikipedia.org/wiki/Richard_Dawkins.

In our latest book (Caine & Caine, 2011) we show that the traditional educational paradigm is a "meme—an organized and taken for granted way of thinking tied to action based on a powerful belief about how the world works, one that is shared by a very large number of individuals." The education meme prevents significantly new ideas from taking hold because it takes for granted such matters as teacher control of content, control of timing for teacher specified goals and assignments, fragmentation of the curriculum into isolated subjects, organization of school life into age-based grade levels, formal assessment based on grade level content, and control of the physical environment for learning in classrooms that remove rather than engage complexity of movement and collaboration.

This is the context within which the Common Core State Standards CCSS) are being implemented. Irrespective of exhortations to the contrary, their organization and manner of implementation expresses the current meme. And so, by themselves, they simply cannot change the ways that teachers teach nor raise the standards achieved by children or the system.

Something radically different is called for. Sylwester (2012) quite accurately called the need to place process over product. From our perspective, that means that educators need to become aware of what we call natural learning. And the CCSS has to be addressed with natural learning in mind. Unless that happens, the hoped for benefits of the CCSS cannot possibly be realized. The system will simply sabotage the new approach.

What is Natural Learning?

Much of how the whole human being is involved in learning has become known over the last two decades as a result of the blend of findings from neuroscience, cognitive psychology, biology, and other fields of study. For instance, meaningful learning:

- Is physiological
- Is dynamic and emergent
- Blends thoughts and emotions
- Is both individual and social, and
- Is compromised by excessive threat, stress and fatigue.

In life, these processes are commingled in the dance of perception and action as evidenced in the work of biologists (e.g., Maturana, Varella, & Paolucci, 1998) and neuroscientists (e.g., Fuster, 2003). There is, first, a perception/action dynamic, which is primarily reflexive. It begins with a simple, reflexive process that can be observed as the eye blinks in response to dust or light. It operates at a more sophisticated level in the momentary adjustments we make during action such as running, driving a car, or imitation-based learning grounded in the operation of mirror neurons.

Beyond the perception/action dynamic are what Fuster calls perception/action cycles. These are the constant problem-solving events with which every one of us deals many times a day. We constantly interpret situations in which we find ourselves, perceive personally relevant problems, explore various modes of action, make decisions, gain feedback, and either learn or don't learn something new.

In natural learning the entire system is engaged in this continuing, ongoing, dynamic process. Hence natural learning is dynamic, interactive, and emergent. It is holistic and embedded in real world experience. It is through multiple perception/action cycles that new patterns and practices form (Caine & Caine, 2011). Hence our definition of "natural learning" is "making sense of experience and developing the capacities to act in and on the world".

Learning in school, organized in terms of the traditional meme, is radically different. Most of it has been confined to memorizing or developing a shallow understanding of content, independent of personal meaning, personal choice, and body/mind interaction. And the CCSS are probably doomed to suffer that fate.

So what can be done? The key need is to understand natural learning, and then to translate it into the school-based practices in which it can thrive. And one way to begin is to look at where natural learning already exists.

We See Natural Learning at Play in Students Engaged in Technology

The world is fast becoming what we call a world of videotech (videos, films, mobile devices of all kinds, and resources such as search engines, YouTube videos, Google, and iMaps, etc.). And most kids are at home in that world. Watch them as they play a video game, do a Web search, or text and talk with others on their smart phones. Better yet, if you haven't already done so, do it with them.

What you will see is that these tech-savvy kids of all ages:

- Are consulting and working with others.

  The concept of "cheating" has largely lost its meaning because they are working and sharing continuously with others in order to solve problems they care about.

- They have chosen to be there, they are pursuing their own interests, and they are asking their own questions.

  Although there is a strong social pull, most participants in videotech are pursuing what is of interest to them, and as they navigate through that world, they are constantly solving their own problems and asking the questions to which they want answers. This takes place within a world of ideas and content that is supplied by their cohort, and not a single expert or adult.

- They get better at things they care about and are open to ways to improve. They are ready to practice skills they decide they need.

  Video games are such a beautiful example. In the course of play, players identify areas that require improvement and in consultation with friends or fellow players determine what is needed.

- Feedback is immediate and constant.

  Video games tell them exactly how good they are at mastering a particular skill or task, and provide indications about what is needed to improve. Feedback includes failure or missed opportunities that they can re-visit and improve on. Students have all sorts of ways to evaluate their own work, and they are constantly exposed to ever increasing levels of expertise to which they can compare themselves.

- They are emotionally engaged.

  Motivation is fueled by emotions and emotions drive action and learning. Notice how these kids get passionate. (They don't always know how to control their emotions but with help they can learn how to take charge of this part of themselves.)

- Have opportunities to self-monitor and pace themselves as needed.

  Working on their own projects usually lets them control the pace and schedule. This allows them to take brief breaks by leaving a task that feels overwhelming. (Note that play can become compulsive and self-regulation tends to be missing in much of the world of videotech).

- They focus for a long time on one project or skill.

  When they really care about a project or situation or game, their attention can be sustained for hours.

- They make many decisions.

  Decisions are critical to developing the most sophisticated areas of the brain. This doesn't happen when students merely do what others tell them to do. Over time they need guidance in how to reflect on what could happen if they wait too long, shift their attention too often, consult an expert for critical input, and so forth. They need to struggle with *how* to do something that doesn't have a yes or no, or a right or wrong, answer.

Ask yourself honestly: Where do students in your school and classes have an opportunity to master curriculum content such as History, Math, Literature, Physics, Science, and Social Studies in a way that incorporates the elements described above. Where do students:

- Consult and work with others?
- Challenge themselves or a group to investigate something they have chosen to do?
- Apply some information, understanding, or skill they investigate as a critical question or puzzle.
- Get immediate feedback on what they do, and from multiple sources?
- Become passionate, exited, or otherwise emotionally engaged?
- Make a plan, schedule, or outline of their work that allows them to pace themselves as needed?
- Focus for a long time on one project or skill that gives them the opportunity to apply a concept, set of skills, or ideas they need to master?
- Make appropriate decisions based on what is needed in order to explore and document their ideas, presentation, or models?

This is how many of our students already function in this new technology rich culture when they are free to do so. It is natural to them. Education was never able to answer how to do this kind of teaching. Technology is in the process of changing all that. The question for us as educators is how to shift our teaching and school culture in order to reflect the real world we now live in. We must adapt and master this new culture.

In a very real sense teachers have to shift their own understanding and actions to match how their students are learning outside of school. And instead of being the controller and director of the essential curriculum, the teacher becomes the master facilitator and the "quality control" expert. A teacher becomes the individual who is there to help students improve. In this spirit they can demonstrate, suggest, question, model, challenge, and enrich student understanding.

From Life to School, and Back Again

As the elements of the dynamic process of natural learning become clear, it becomes possible to reframe education. Standards can be embedded into guided experiences so that students come to master new material and processes in ways that match natural functioning. The key is to grasp and then incorporate the core elements of the perception/action cycle. Clearly there are both linear and nonlinear aspects to the overall process. For the purposes of making them clear, we spell them out in a sequence.

To begin with, an appropriate degree of immersion in the content matter needs to exist (think of the way that an infant is naturally immersed in its native language, or a young child with musical parents is immersed in music).

The context matters enormously. It needs to consist of complex situations that are naturally organized so that the whole of a person can be engaged. What does this look like in practice? The most useful umbrella concept that we have found is a sophisticated version of what is called *project-based learning.* This has been the focus of much attention in the past (e.g., see Edutopia). The problem is that the phrase project-based learning is ambiguous.

- It can just refer to teacher-constructed activities. These can be useful but are very limited in accessing students' natural capacities for learning.
- It can refer to more complex projects and problems, where the teacher designs the project and formulates the questions. This is a significant advance but still suppresses much of the dance of perception and action.
- The key is to find a way for students to ask their OWN questions and design their OWN projects, preferably with real world timelines that may last a semester or longer, and with guidance, support, and feedback from educators. This is the sophisticated form of project-based education that capitalizes on the full depth of natural learning. Our own version, spelled out in *Natural Learning for a Connected World,* is called the Guided Experience Approach (Caine & Caine, 2011).

Within this context, students must be able to:

- Link the new to something that is somewhat familiar already.
- Formulate and engage their own personally meaningful questions, puzzles, or problems.
- Have access to and be exposed to expert knowledge or important information.
- Have the opportunity to apply the new knowledge or information to something they care about.
- Engage in an ongoing dance between continuous and emerging questions, experimentation, and coaching;
- Receive and be able to take advantage of continuous feedback (formative assessment).
- Make it real by acting in some new way or creating something new and making it available to expert judgment and feedback (summative assessment).

Note that the core elements of traditional teaching are **not** discarded. There may be times for rote memory; there is often a need for a teacher or coach to provide explanations; practice and rehearsal in the development of new skills will always be critical (as the research on expertise makes clear). **All** of these, however, need to be incorporated into the larger playing out of perception/action cycles. The entire process is therefore dynamic. And all of it continues to be influenced by the degree of stress, the types of threat and challenge, and the nature of the community and relationships within which the entire process takes place.

Embedding Common Core State Standards

The challenge, now, given that Common Core State Standards are a fact of life, is to integrate the CCSS with natural learning as described above. There has to be some give and take because standards, by their very nature, tend to disregard the internal worlds of meaning of the students. The standards are always imposed from the outside, as it were, and need to be brought "inside" so they can be used by students in order to make better sense of the world and to develop additional real world capacities. With that in mind:

- This type of learning begins with positive relationships grounded in mutual respect and decision-making. Collaboration is essential and basic routes and procedures must be in place.
- Even though standards may be framed for individual subjects, they should not be taught in isolation. Rather they should be taught "across" the curriculum because they are often part and parcel of other subjects and of real life situations.
- Real life, natural learning, and good project-based teaching have their own time lines. Just as in the real world, these will be constrained by circumstances. But they cannot and must not be ignored. That means that the "content" of the CCSS may be important, but the organization and timing of the elements needs to be freed up to match good teaching and deep learning.
- Realize that there are major developmental differences in "normal" students. Ideally, projects can provide an environment for students who are developing at different rates.
- Authentic assessment must be front and center. See http://pareonline.net/getvn.asp?v=2&n=2. The moment that test scores prevail in the minds of students and teachers, most of the power of natural learning is leeched out and the traditional meme prevails. This does **not** mean that scores on tests are irrelevant. Rather, educators need to come to terms with the oft demonstrated fact that students will naturally perform better on tests when their learning is deep and personal.

Can It Be Done?

It can be done and it is being done. In our 2011 book we describe two superb schools that illustrate the theory and the practice. One is a set of nine schools, collectively known as High Tech High in San Diego. See http://www.hightechhigh.org/about/. The other is Bridgewater school in South Australia. See http://www.bridgeps.sa.edu.au/. There are also many other organizations and schools that are tending in this direction. They range from the EdVision schools (see http://www.edvisions.com/) to the Alternative Education Resource Organization (see http://www.educationrevolution.org/about-aero/).

And it is a pleasure to watch the masters of this very sophisticated approach as they bring natural learning to the fore, day in and day out, within a culture where educators themselves consciously engage their own on-going learning and perception/action processes.

References

Caine R., & Caine, G. (2011). *Natural learning for a connected world: Education, technology and the human brain*. New York: Teachers College.

Capra, F. (1997). *The web of life: A new scientific understanding of living systems.* Anchor.

Damasio, A.R. (1994). *Descartes' error: Emotion, reason and the human brain.* New York: Avon.

Edutopia. See http://www.edutopia.org/.

Fuster, J.M. (2003). *Cortex and mind: Unifying cognition.* New York: Oxford University.

Maturana, H.R., Varela, F.J., and Paolucci, R. (1998). *The tree of knowledge: The biological roots of human understanding.* Boston: Shambhala.

Sylwester, R. (2012). The beginning search for an appropriate education. In *Creating an appropriate 21st century education.* Eugene, OR: Information Age Education. Retrieved 2/2/2013 from http://i-a-e.org/downloads/doc_download/243-creating-an-appropriate-21st-century-education.html.

"The principal goal of education in the schools should be creating men and women who are capable of doing new things, not simply repeating what other generations have done." (Jean Piaget; Swiss philosopher, natural scientist, and educator, well known for his work studying children and his 4-stage theory of cognitive development; 1896–1980.)

"In times of change, the learner will inherit the earth while the learned are beautifully equipped for a world that no longer exists." (Eric Hoffer; American social writer and philosopher; 1902–1983.)

Chapter 10. Some Additional Important CCSS Topics

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[IAE Newsletter #109. See http://i-a-e.org/newsletters/IAE-Newsletter-2013-109.html.]

My recent Google search of the quoted term "Common Core State Standards" produced nearly 27 million hits. This chapter lists a number of important aspects of the Common Core State Standards initiative not covered previously the newsletter series or this book. For most of these, I merely list the topic. However, for three of them I have provided a short introduction that cites and summarizes a couple of references that I have found appealing.

IAE is seeking volunteers who will take one or more of these topics—or other topics of their choice—and develop them into full-blown chapters. These chapters will be added to the book. The Web edition of the free book will be updated to include these new chapters. Please send your ideas and/or draft chapters to me at moursund@uoregon.edu.

List of Some Potential CCSS Topics

Here are some additional topics that are well deserving of inclusion in discussions about CCSS.

- *CCSS Approaches to Assessment.* See a section on this topic later in this chapter. Currently, there is a growing movement by students and teachers to boycott such state and national assessments. See http://i-a-e.org/iae-blog/are-we-missing-the-point-of-effective-assessment.html. For some estimates of the length of time it will take students to do the assessments, see http://blogs.edweek.org/edweek/curriculum/2013/03/assessment_consortium_releases_2.html.
- *Education for the Future.* Education prepares students for their future lives. See http://iae-pedia.org/What_the_Future_is_Bringing_Us.
- *Impact on the Publishing Industry*. The CCSS initiative allows for states to individualize some of the content and assessment to fit their needs. This opens up the possibility for smaller for-profit and non-profit organizations to develop materials that are specific to the needs and desires of individual states.

- *Information Literacy in the CCSS Disciplines.* How do students learn to effectively evaluate and use the information they locate? The Big6™ Skills is an information problem-solving process that can help students to achieve educational standards by giving them strategies to accomplish the "able to do" part of the definition of standards. See http://janetsinfo.com/Big6_CCSSIStds.htm. For a free seven-page paper on teaching students to evaluate information, see http://email.eyeoneducation.com/public/webform/render_form/8pynvvhbrha1w18zubml3yahzj6ks/db582c1ea476ab674aff7b00112e2f0b/addcontact.
- *Staff Development.* A number of school districts have started on the needed staff development. However, there seems to be little information about the nature, extent, and duration of the staff development that is needed.
- *Students with Special Needs.* See http://shop.ascd.org/Default.aspx?TabID=55&ProductId=75570633 and http://i-a-e.org/newsletters/IAE-Newsletter-2011-77.html.
- *Talented and Gifted Education.* See http://iae-pedia.org/Talented_and_Gifted_Education.
- *The Case against CCSS.* See a section on this topic later in this newsletter. A recent blog posting by Diane Ravitch at http://dianeravitch.net/2013/02/26/why-i-cannot-support-the-common-core-standards/ summarizes her concerns with CCSS.
- *Computational Thinking and CCSS.* The media of Information and Communication Technology (ICT) and the thinking underlying use of ICT tools has the potential to produce substantial changes in our educational system. See a section on this topic later in this newsletter.
- *Theories of Cognitive Development and Intelligence.* See http://iae-pedia.org/Cognitive_Development.
- *Theories of Learning and Teaching.* See http://iae-pedia.org/College_Student%E2%80%99s_Guide_to_Computers_in_Education/Chapter_6:_Learning_and_Learning_Theory.
- *Transfer of Learning.* See http://iae-pedia.org/Transfer_of_Learning.

The Case Against CCSS

There are many people who argue against the CCSS initiative. In brief summary, they present two major cases:

1. Our educational system is quite good. There is insufficient evidence for the types of changes incorporated into the CCSS initiative. Such changes may decrease the overall quality of our precollege educational system.
2. Our educational system has considerable room for improvement. However, there is little if any data to support the idea that the CCSS approach will achieve the needed improvements.

The first case is presented in the two articles that follow: Lind (8/1/2012) and Zhao (2/27/2012).

Quoting Michael Lind:

> To begin with, the U.S. public school system is hardly the abysmal failure portrayed in the conventional wisdom. The international comparative data is skewed, …
>
> If you look at the facts, then, they don't suggest that the U.S. public K-12 system is a failure. Rather American public education is a world-class success except among poor natives and immigrants, whose educational challenges have more to do with poverty and rural cultural legacies than alleged failings of public K-12.

Quoting Yong Zhao:

> America is on the precipice of ruining its foundation for success. The movement toward a centralized education system through federal mandates and common curriculum and testing is threatening the very system that has contributed to America's success and that holds the potential for its future success: that is a decentralized, diverse, largely locally controlled education system.
>
> …
>
> Even without empirical evidence to support their proposals, these new reformers are winning the day.…

CCSS Approaches to Assessment

We all know that timely and informative feedback (*formative assessment*) is essential to learning. Such feedback can be provided by the learner and/or from external sources. Students can learn to reflect on what they are learning, and they can also do metacognition to analyze their thinking about the content they are studying. Self-assessment is an important component of learning. See http://iae-pedia.org/Self-assessment_Instruments#Introduction.

Two other forms of assessment are *summative assessment* and *residual impact assessment*. Summative assessment provides information about how well students have learned at the end of a unit or course of study. Residual impact assessment provides information on long-term retention of the knowledge and skills a student has studied in a unit of course of study. Both forms of assessment are useful to students, teachers, instructional designers, and the many different groups of educational stakeholders.

The CCSS initiative is committed to developing assessment instruments that can be used on a nation-wide basis and administered via computer. A number of CCSS assessment resources are briefly discussed at http://educationnorthwest.org/resource/1331. There are two major Federally-funded groups working on CCSS assessment.

Smarter Balanced Assessment Consortium (SBAC)

Pilot testing is scheduled for February through May 2013. Quoting from SBAC:

> The Smarter Balanced Assessment Consortium (Smarter Balanced) is a state-led consortium working to develop next-generation assessments that accurately measure student progress toward college- and career-readiness. Smarter Balanced is one of two multistate consortia awarded funding from the U.S. Department of Education in 2010 to develop an assessment system aligned to the Common Core State Standards (CCSS) by the 2014-15 school year.

Quoting from http://www.smarterbalanced.org/pilot-test/:

> K-12 teachers and higher education faculty from Smarter Balanced Governing States collaborated with content experts to write and review items and performance tasks that appear in the Pilot Test. In addition, Smarter Balanced conducted more than 900 cognitive labs around the country in 2012. Through these one-on-one sessions, students provided valuable feedback on innovative item types, the test interface, and accessibility features. Small-scale trials in more than 500 schools in 23 states also provided critical information for the development of the Pilot Test.

See some sample test items at http://www.smarterbalanced.org/sample-items-and-performance-tasks/.

Partnership for Assessment of Readiness for College and Careers (PARCC)

Quoting from PARCC:

> The U.S. Department of Education awarded "Race to the Top" assessment funds to the Partnership for the Assessment of Readiness for College and Careers (PARCC or Partnership) for the development of a K-12 assessment system aligned to the Common Core State Standards in English language arts and mathematics. Florida is a member of this Partnership of 23 states, whose primary goal is to help states dramatically increase the number of students who graduate from high school ready for college and careers. Together the PARCC states educate approximately 25 million K-12 public school students in the United States.

See some sample test items at http://www.parcconline.org/samples/item-task-prototypes#7.

Computational Thinking and CCSS

Here is a frequently quoted statement by Marshall McLuhan:

> "The medium is the message. This is merely to say that the personal and social consequences of any medium—that is, of any extension of ourselves—result from the new scale that is introduced into our affairs by each extension of ourselves, or by any new technology." (Marshall McLuhan; Canadian educator, philosopher, and scholar; 1911–1980.)

Today's students spend a great deal of their time immersed in the medium of texting, instant messaging, email, cell phone conversations, and using a wide variety of computer-based and/or television-based forms of entertainment.

The people involved in the CCSS initiative are well aware of this new medium. They are designing CCSS summative assessment that is computer-based and adapts to individual students.

However, they are mostly ignoring how important Information and Communication Technology has become, both as an everyday medium for students and as an aid to representing and solving problems in the various disciplines that are taught and/or could be taught in the K-12 curriculum.

Computational thinking is a term used to summarize the routine combining of ICT capabilities and the human mind in representing and solving problems (Moursund, 2011, 2012). Quoting from the Center for Computational Thinking (http://www.cs.cmu.edu/~CompThink/):

- Computational thinking is a way of solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science. To flourish in today's world, computational thinking has to be a fundamental part of the way people think and understand the world.

- Computational thinking means creating and making use of different levels of abstraction, to understand and solve problems more effectively.
- Computational thinking means thinking algorithmically and with the ability to apply mathematical concepts such as induction to develop more efficient, fair, and secure solutions.

Final Remarks

The CCSS initiative represents the work of a great many dedicated educators. The results of this work will be with us for many years. Thus, it behooves all of us to understand the changes that are being implemented due to the CCSS initiative, how they will affect the quality of education that students receive, how they will impact teachers and other educational employees and volunteers, and how they will impact the publishing and assessment industries.

References

Lind, M. (8/1/2012). *Educational reform's central myths.* Retrieved 2/23/2013 from http://www.salon.com/2012/08/01/school_choice_vs_reality/.

Moursund, D. (2011). *Computational thinking.* IAE-pedia. Retrieved 2/27/2013 from http://iae-pedia.org/Computational_Thinking.

Moursund, D. (2012). *Two brains are better than one.* IAE-pedia. Retrieved 2/27/2013 from http://iae-pedia.org/Two_Brains_Are_Better_Than_One.

PARCC. *Partnership for Assessment of Readiness for College and Careers.* Retrieved 2/23/2013 from http://www.fldoe.org/parcc/.

SBAC. *Smarter Balanced Assessment Consortium.* Retrieved 2/23/2013 from http://www.smarterbalanced.org/.

Zhao, Y. (2/7/2012). Mass localization for improving America's schools. *Kappa Delta Pi Record.* Retrieved 2/23/2013 from http://www.tandfonline.com/doi/abs/10.1080/00228958.2012.654714.

"The aim [of education] must be the training of independently acting and thinking individuals who, however, can see in the service to the community their highest life achievement." (Albert Einstein; German-born theoretical physicist and 1921 Nobel Prize winner; 1879–1955.)

An individual understands a concept, skill, theory, or domain of knowledge to the extent that he or she can apply it appropriately in a new situation." (Howard Gardner; American psychologist and educator; 1943–.)

Appendix: Goals for Education in the United States

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[IAE-pedia. See http://iae-pedia.org/Goals_of_Education_in_the_United_States.]

Global Goals for Education

Education is a local, regional, state, national, and global issue. This IAE-pedia entry is about goals for education in the United States. However, we begin with two very general quotes about global education. Notice that neither of these statements provides details of curriculum content, assessment, or years of available or required schooling.

> "Education is a human right with immense power to transform. On its foundation rest the cornerstones of freedom, democracy and sustainable human development." (Kofi Annan; Ghanaian diplomat, seventh Secretary-General of the United Nations, winner of 2001 Peace Prize; 1938–.)

On 16 February 2012, the General Assembly of the United Nations passed the *United Nations Declaration on Human Rights Education and Training.* Quoting from that document:

> The General Assembly,
> Reaffirming the purposes and principles of the Charter of the United Nations with regard to the promotion and encouragement of respect for all human rights and fundamental freedoms for all without distinction as to race, sex, language or religion,
>
> Reaffirming also that every individual and every organ of society shall strive by teaching and education to promote respect for human rights and fundamental freedoms,
>
> **Reaffirming further that everyone has the right to education,** and that education shall be directed to the full development of the human personality and the sense of its dignity, enable all persons to participate effectively in a free society and promote understanding, tolerance and friendship among all nations and all racial, ethnic or religious groups, and further the activities of the United Nations for the maintenance of peace, security and the promotion of development and human rights… [Bold added for emphasis.] See http://www2.ohchr.org/english/issues/education/training/UNDHREducationTraining.htm.

Pay particular attention to the last paragraph in the United Nations statement. It asserts that education is a human right, but it also asserts that one of the purposes (goals) for education is to "enable all persons to participate effectively in a free society and promote understanding, tolerance and friendship among all nations and all racial, ethnic or religious groups."

Some History of Education in the United States

The U.S. Declaration of Independence signed on July 4, 1776, contains the following statement:

> "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their creator with certain unalienable Rights, that among these are Life, Liberty, and the pursuit of Happiness."

The U.S. Declaration of Independence does not say anything specifically about education or schooling. However, notice that there is some similarity between this declaration of inalienable rights and the third paragraph in the United Nations statement quoted above.

Thomas Jefferson, third president of the U.S., played a major role in writing the Declaration of Independence. He was a strong proponent of education. This next quote is from a bill Thomas Jefferson brought before the Virginia Legislature in 1778. The legislation was titled A Bill for the More General Diffusion of Knowledge. It was not passed. See http://en.wikipedia.org/wiki/Thomas_Jefferson_and_education.

> "At every one of these schools shall be taught reading, writing, and common arithmetick, and the books which shall be used therein for instructing the children to read shall be such as will at the same time make them acquainted with Graecian, Roman, English, and American history. At these schools all the free children, male and female, resident within the respective hundred, shall be intitled **to receive tuition gratis, for the term of three years,** and as much longer, at their private expence, as their parents, guardians or friends, shall think proper." [Bold added for emphasis.]

Notice that the goal was to provide free education up through the third grade for free (not slave) boys and girls. For information about the literacy level in the U.S. at that time, see http://www.history.org/foundation/journal/winter11/literacy.cfm. A free third grade education for all—stressing reading, writing, and arithmetic—was still a rather "far out" idea. At that time, schools and schooling were determined at a local level, with each village, town, or city developing its own schools and curriculum.

The U.S. Constitution and the Bill of Rights (the first 10 amendments to the Constitution) do not mention education or schools. The 10th Amendment to the U.S. Constitution states:

> The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

Thus, education and schools were rights left to the states.

Movement Toward National Educational Goals and Standards

Historically, educational goals and standards in the U.S. have largely been determined first by local communities and later by the individual states. During the past century, there have been a number of approaches to changing this situation. Three important ones are:

- Broadly-based businesses such as the textbook publishing industry and other media, and the computer industry.
- Professional educational societies and organizations.
- State and Federal Governments.

Broadly-based Businesses

The publishing industry provides a good example. For a great many years, the McGuffey Readers were the standard for elementary school curriculum. Quoting from the Wikipedia (http://en.wikipedia.org/wiki/McGuffey_Readers):

> McGuffey Readers were a series of graded primers that were widely used as textbooks in American schools from the mid-19th century to the mid-20th century, and are still used today in some private schools and in homeschooling.
>
> It is estimated that at least 120 million copies of McGuffey Readers were sold between 1836 and 1960, placing its sales in a category with the Bible and Webster's Dictionary.… No other textbook bearing a single person's name has come close to that mark.

Today we have a massive textbook publishing industry. Publishers strive to develop textbooks that fit the nation as a whole, and then modify their books to meet specific requirements of particularly large state markets.

The "new kid on the block" is a combination of computer-based instruction and distance learning. These provide nationwide examples of content, teaching methodologies, and assessment. Indeed, recently developed Massively Open Online Courses (MOOC) are reaching international audiences and contributing to global educational content standards. See http://en.wikipedia.org/wiki/Massive_open_online_course.

Professional Societies and Organizations

Many professional educational societies and organizations have helped to establish national standards. Social Studies provides an excellent example. Quoting from http://www.answers.com/topic/overview-of-social-studies-education:

> The contemporary social studies curriculum has its roots in the Progressive education movement of the early twentieth century. With its emphasis on the nature of the individual learner and on the process of learning itself, the movement challenged the assumptions of subject-centered curricula. Until this time, the social studies curriculum was composed of discrete subject areas, with a primary emphasis on history. To a slightly lesser degree, geography and civics were also featured, completing the triumvirate.
>
> There were indications that change was coming when the 1893 Report of the Committee of Ten on Secondary School Studies advocated an interdisciplinary approach in the social studies. By 1916 the National Education Association (NEA) Committee on the Social Studies was urging that an interdisciplinary course of instruction be created based on the social sciences. When the NEA 1916 report established social studies as the name of the content area, it presented the scope and sequence that is still in use at the start of the twenty-first century. Social studies received further support when the 1918 Cardinal Principles of Secondary Education called for the unified study of subject areas heretofore taught in isolation. This course, called social studies, would have as its main goal the cultivation of good citizens…

The National Council for the Social Studies was founded in 1921, and is the largest organization in the United States to focus exclusively on social studies education.

Many of the academic discipline organizations include a focus on goals and standards for precollege education. Here are a few examples that have had nation-wide impacts:

- American Association of School Librarians. See http://www.ala.org/aasl/.
- International Reading Association. See http://www.reading.org/.
- International Society for Technology in Education. See http://www.iste.org/standards.
- National Association for Music Education. See http://musiced.nafme.org/resources/national-standards-for-music-education/.
- National Council for Accreditation of Teacher Education. See http://www.ncate.org/Standards/tabid/107/Default.aspx.
- National Council for the Social Studies. See http://www.uni.edu/icss/standards.html.
- National Council of Teachers of English. See http://ncte.connectedcommunity.org/Home/.
- National Council of Teachers of Mathematics. See http://www.nctm.org/standards/content.aspx?id=16909.
- National Science Teachers Association. See http://www.nsta.org/.

Nationwide State and Federal Government Approaches

A third approach to national educational goals and standards has been via organizations representing the states and by the Federal Government. The Common Core State Standards are a major current initiative to develop standards that are national in scope. They cover English Language Arts, Math, Science, and History. This is an initiative by the National Governors Association Center for Best Practices and the Council of Chief State School Officers. Quoting from http://www.corestandards.org/:

> The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy.

Federal involvement in education has a long history. In 1867, President Andrew Jackson signed legislation that created the first Department of Education. See http://www.cis.drexel.edu/faculty/shelfer/public_html/busrefpapers/edu.htm.) The Department of Education was demoted to an Office of Education in 1868. Quoting from the Wikipedia (http://en.wikipedia.org/wiki/United_States_Department_of_Education)

> As an agency not represented in the president's cabinet, it quickly became a relatively minor bureau in the Department of the Interior. In 1939, the bureau was transferred to the Federal Security Agency, where it was renamed the Office of Education. In 1953, the Federal Security Agency was upgraded to cabinet-level status as the Department of Health, Education, and Welfare.

> The Office of Education grew within the Department of Health, Education, and Welfare. By 1979, the Office of Education had 3,000 employees and an annual budget of $12 billion. President Jimmy Carter advocated for the creation of a separate Department of Education with its own cabinet-level status. Congress approved this, and the newly established Department of Education was provided an annual budget of $14.2 billion and a staff of 17,000 employees. Rapid growth has continued, with a 2012 budget of approximately $68 billion.

There is a growing history of the states and the Federal Government working together on educational goals and standards. Quoting from U.S. Chamber of Commerce document, Background to Standards Implementation (http://icw.uschamber.com/content/uneven-progress):

> Developing and implementing academic standards and their impact on college and career readiness have been major objectives for state and federal policymakers since the 1980s. In 1989, President George H.W. Bush convened governors for a historic education summit to focus on key national education goals. This discussion led to the creation of the National Education Goals Panel and the National Council on Education Standards and Testing. Many of the ideas developed from this effort were incorporated into the Goals 2000 Act, one of the first education policy initiatives by the Clinton administration in 1993.
>
> Goals 2000 created the National Education Standards and Improvement Council (NESIC), which was intended to provide an independent, voluntary certification of state academic standards, "opportunity-to-learn" standards, and assessment systems. Opportunity-to-learn standards were provided to ensure a minimum level of necessary conditions for learning, including resources capacities. Because these standards represented a departure from the long tradition of state and local control over education, these concepts quickly became controversial and were repealed when Republicans took control of Congress in 1994.
>
> Congress passed the Improving America's Schools Act (IASA) in 1994. IASA largely began what has been nearly a two-decade focus on academic standards in federal education law. This statute required that states develop and implement academic standards for elementary and secondary education as a condition of receiving federal education funding under the Elementary and Secondary Education Act (ESEA). This requirement was expanded and enforced as part of the latest reauthorization of ESEA, referred to as the No Child Left Behind Act of 2001 (NCLB). Importantly, under both statutes, states retained control over the content of their academic standards and related assessments.

Goals for Education in the United States

There is widespread agreement that students deserve to have good educational opportunities. There is less agreement on what should be the specific goals for education, and there is still less agreement on what the standards should be for content, teaching, and assessment.

In the U.S. at the current time, the Secretary of Education indicates that "the goal" of precollege education is college and career readiness. See http://i-a-e.org/iae-blog/college-and-career-readiness.html. That is a gross over-simplification of what our educational system is about, and it misses much of the breadth in the list of goals provided in this document.

The early part of my teaching career focused on teaching math and uses of computers to help solve math problems. I built on this background as I first began teaching teachers in summer institute programs funded by the National Science Foundation. At that time, the goals of education seemed clear and simple to me. They were:

1. To help students learn some facts.
2. To help students learn to think, solve challenging problems, and accomplish challenging tasks using the facts.

The teachers I taught soon taught me how naïve I was. As I moved more and more into being a math educator, computer educator, and teacher of teachers, I gradually came to understand the complexity of education and the wide range of goals that help to define our educational system.

About 25 years ago, my colleague Dick Ricketts and I spent considerable time analyzing the commonly discussed goals of education and we published our findings as an appendix in *Long-range Planning for Computers in Schools* (Moursund & Ricketts, 1988). Since then I have used this list in teaching many different courses and in several of my books. Gradually I have refined and updated the list. This IAE-pedia entry represents my latest thinking on the topic. I hope it will help you to develop a personal philosophy that will serve your needs as an educator.

The list has been divided into three categories: Conserving Goals, Achieving Goals, and Accountability Goals. In most societies, education has a major goal of conserving and preserving the culture and values of the society. Interestingly, this tends to create some stress between Conserving Goals and Achieving Goals. As students gain increasing knowledge and skills, they sometimes rebel against the conservative nature of schools and their society.

Conserving Goals

G1 Security: All students are safe from emotional and physical harm. Both formal and informal educational systems must provide a safe and secure environment designed to promote learning.

> Comment: In recent years there has been a great deal of media coverage about potential physical and emotional harm that students may encounter in school. This includes bullying, shootings, access to inappropriate information through use of the Internet.

G2 Values and Diversity: All students respect individual differences and the traditional values of the family, community, state, nation, and world in which they live.

> Comment: A good summary is provided in the United Nations Declaration of Human Rights. See http://www2.ohchr.org/english/issues/education/training/UNDHREducationTraining.htm. Quoting from the document:
>
> Reaffirming the purposes and principles of the Charter of the United Nations with regard to the promotion and encouragement of respect for all human rights and fundamental freedoms for all without distinction as to race, sex, language or religion,
>
> Reaffirming also that every individual and every organ of society shall strive by teaching and education to promote respect for human rights and fundamental freedoms,
>
> Reaffirming further that everyone has the right to education, and that education shall be directed to the full development of the human personality and the sense of its dignity, and enable all persons to participate effectively in a free society and promote understanding,

tolerance and friendship among all nations and all racial, ethnic or religious groups, and further the activities of the United Nations for the maintenance of peace, security and the promotion of development and human rights…

G3 Sustainability: All students value a healthy and sustainable local, regional, national, and global environment, and they knowingly work to improve the quality of the environment.

Comment: The following is quoted from http://en.wikipedia.org/wiki/Sustainability:

…since the 1980s sustainability has been used more in the sense of human sustainability on planet Earth and this has resulted in the most widely quoted definition of sustainability as a part of the concept of sustainable development, that of the Brundtland Commission of the United Nations on March 20, 1987 (http://en.wikipedia.org/wiki/Brundtland_Commission): "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

At the 2005 World Summit on Social Development it was noted that this requires the reconciliation of environmental, social equity, and economic demands—the "three pillars" of sustainability…

Achieving Goals

G4 Full Potential: All students are knowingly working toward achieving and increasing their healthful physical, mental, and emotional lifelong potentials.

Comment: Notice the emphasis on students "knowingly" working to increase their potentials. The goal is to empower students to empower themselves to develop life-long physical and mental habits that promote and sustain personal well being.

G5 Basic Skills: All students gain a working knowledge of speaking and listening, observing (including visual literacy), reading and writing, mathematics, logic, and storing, retrieving, and communicating information. All students learn to solve problems, accomplish tasks, deal with novel situations, and carry out other higher-order cognitive activities that make use of these basic skills.

Comment: Basic skills tend to have long (perhaps lifelong) value. However, new developments can change existing basic skills and add new basic skills. For example, the fluent use of Information and Communications Technology systems is an emerging basic skill.

G6 Setting and Achieving Personal Learning Goals: All students gain the knowledge and skills to set and achieve personal learning goals.

Comment: Such knowledge and skills, along with self-understanding of one's interests, intrinsic motivation, drives, and ambition, can serve a person through their lifetime.

G7 General Education: All students have appreciation for, knowledge about, and understanding of a number of general areas of education, including:

- Artistic, intellectual, scientific, social, and technical accomplishments of humanity.
- Cultures and cultural diversity.
- Geography.

- Governments and governance.
- Health and medicine.
- Nature in its diversity and interconnectedness.
- Religions and religious diversity.
- Science, technology, engineering, and mathematics (STEM).
- Social science.

> Comment: A good education is a balance between breadth and depth, and it varies considerably from person to person. “Try to learn something about everything and everything about something.” (Thomas H. Huxley; English writer; 1825–1895.)

G8 Lifelong Learning: All students learn how to learn and how to make effective use of what they learn. They have the inquiring attitude and self-confidence that allows them to pursue life’s options. They have the knowledge and skills needed to deal effectively with changes that affect them.

> Comment: The pace of technology-based change is quickening, and the total collection of human knowledge is growing very rapidly. All students need to develop lifelong habits of mind that help them to gain the knowledge, skills, and understanding needed to effectively accommodate ongoing change. Some current areas of rapid change include genetics (genome projects), nanotechnology, cognitive neuroscience, medicine, and computer technology.

G9 Problem Solving: All students make use of decision-making and problem-solving skills and tools, including the higher-order skills of analysis, synthesis, and evaluation. All students pose and solve problems, making routine and creative use of their overall knowledge and skills, and currently available technologies.

> Comment: Recognizing, understanding, clearly communicating, and effectively working to solve problems lie at the heart of each academic discipline. See http://iae-pedia.org/Problem_Solving.

G10 Productive Citizenship: All students act as informed, productive, and responsible members of countries, organizations to which they give allegiance, and as members of humanity as a whole.

> Comment: The world is growing smaller. In some sense, each person is a citizen of the world, one or more countries, one or more states/provinces, and so on. During a lifetime, a person is apt to hold a variety of jobs and/or pursue a variety of careers. A person is apt to belong to a variety of organization and/or groups.

G11 Social Skills: All students interact publicly and privately with peers and adults in a socially acceptable and positive fashion.

> Comment: Information and Communication Technology has brought us new forms of communication and social interaction, including desktop conferencing, picture phones, instant messaging, email, and groupware.

G12 Information and Communication Technology (ICT): All students have appropriate knowledge and skills for using our rapidly changing ICT as well as related technologies relevant to their lives and our world.

> Comment: ICT is both a discipline in its own right and a driving force for change in education and in many different areas of technology, science, and research. Computational thinking is becoming a standard complement of each academic discipline. See http://iae-pedia.org/Computational_Thinking.

Accountability

G13 Assessment: The various components of an educational system that contribute to accomplishing the goals (such as those listed above) are assessed in a timely and appropriate manner. The assessments provide formative, summative, and long-term impact evaluative data that can be used in maintaining and improving the quality of the educational system.

> Comment: Accountability and assessment are strongly intertwined. In the past two decades, the issue of authentic assessment has received a lot of attention. As ICT is more thoroughly integrated into curriculum content, authentic assessment of student learning becomes a new challenge to educational systems. Electronic portfolios are gradually increasing in importance as an aid to authentic assessment.

G14 Accountability: All educational systems are accountable to key stakeholder groups, including:

- Students.
- Parents and other caregivers of the students.
- Teachers, administrators, and all employees and volunteers in educational systems.
- Voters, taxpayers, and funding agencies.
- Employers.

> Comment: Accountability includes gathering and effectively using information from formative, summative, and long-term residual impact assessments that are fair, reliable, valid, and timely. It is difficult to make changes to our educational system because of the need to address the widely divergent interests of the various stakeholders. However, this democratic approach to our educational system is one of its strengths.

Final Remarks

An educational system is a compromise among known teaching and learning theories, current and other possible teaching practices, and stakeholders. The complexity of an educational system and its compromises make it difficult to substantially improve the system. However, there are powerful change agents at work, such as the Common Core State Standards initiative, Information and Communication Technology, research in cognitive neuroscience, and national and global competition. We have the technology and research base to substantially improve education. It is important that all stakeholders come together to agree to support any long-range plans for improvement.

Informal and formal education together have become a complex and challenging human endeavor. Educational leaders and others interested in education address these challenges by developing educational goals, standards, and ways to assess meeting the goals by achieving the standards. All of these activities are human endeavors—they are not exact sciences.

There is an emerging discipline named the Scholarship of Teaching and Learning, but it is still in its infancy (Moursund, 2010 and 2012). This discipline is being substantially impacted by computer technology, our growing ability to develop and teach Massive Open Online Courses (Moursund, 2/27/2012), and progress in brain science.

References

Moursund, D. (2010). *All educators are engaged in the scholarship of teaching and learning.* IAE Blog. Retrieved 3/16/2016 from

Moursund, D. (2012). *Scholarship/science of teaching and learning.* IAE-pedia. Retrieved 2/12/2013 from http://iae-pedia.org/Scholarship/Science_of_Teaching_and_Learning.

Moursund, D. (2/27/2012). *Supersized online courses.* IAE Blog. Retrieved 2/12/2013 from http://i-a-e.org/iae-blog/all-educators-are-engaged-in-the-scholarship-of-teaching-and-learning.html.

Moursund, D., & Ricketts, R. (1988). *Long-range planning for computers in schools.* Eugene, OR: International Society for Technology in Education. This book includes the initial collection of goals of education developed by Moursund and Ricketts. Over the years, this list has been updated several times. The version in this current IAE book represents considerable refinement of the original list.

References

Achieve. Retrieved 1/13/2013 from http://www.achieve.org.

ASCD. *Common Core: 7 Recommendations for effective implementation.* See http://thejournal.com/articles/2012/11/01/common-core-7-recommendations-for-effective-implementation.aspx?admgarea=News1.

ASCD. *Smartbrief. Common Core guide: Students should read more of everything.* See http://www.smartbrief.com/servlet/encodeServlet?issueid=B483129B-F8DA-4AE4-AAD4-92FCFC38A8B2&sid=f0bb33a3-9171-4453-bc8d-d942386e1ee8.

Boyer, E. (1990). *Scholarship reconsidered: Priorities of the professoriate*. San Francisco: Jossey-Bass.

Caine R., & Caine, G. (2011). *Natural learning for a connected world: Education, technology and the human brain*. New York: Teachers College.

Capra, F. (1997). *The web of life: A new scientific understanding of living systems.* Anchor.

CCSS (2010). *Common Core State Standards Initiative.* Retrieved 2/21/2013 from http://www.corestandards.org/the-standards.

CCSS (2012). *Statements of support.* See http://www.corestandards.org/about-the-standards/statements-of-support.

College and career readiness. Retrieved 1/13/2013 from http://www.collegecareerready.org.

Damasio, A.R. (1994). *Descartes' error: Emotion, reason and the human brain.* New York: Avon.

Dewar, J., & Bennett, C. (2010). *Situating SoTL within the disciplines: Mathematics in the United States as a casestudy.* Retrieved 10/29/2012 from http://academics.georgiasouthern.edu/ijsotl/v4n1/essays_about_sotl/_DewarBennett/index.html.

Education Next. The war against the Common Core. See http://educationnext.org/the-war-against-the-common-core/.

Edutopia. See http://www.edutopia.org/.

Fuster, J.M. (2003). *Cortex and mind: Unifying cognition.* New York: Oxford University.

ISTE (2013). ISTE books about NETS. ISTE Bookstore. Retrieved 11/25/2012 from http://www.iste.org/store/books-courseware/all-books.

ISTE NETS•S (2007). *ISTE National Educational Technology Standards for Students: 2007 profiles.* Retrieved 11/23/2012 from http://www.iste.org/standards/nets-for-students/nets-for-students-2007-profiles.

Lind, M. (8/1/2012). *Educational reform's central myths.* Retrieved 2/23/2013 from http://www.salon.com/2012/08/01/school_choice_vs_reality/.

Luehrmann, A. (1972). *Should the computer teach the student, or vice-versa?* Retrieved 11/20/2012 from http://www.citejournal.org/vol2/iss3/seminal/article2.cfm.

Man: A course of study. See http://en.wikipedia.org/wiki/Man:_A_Course_of_Study.

Maturana, H.R., Varela, F.J., & Paolucci, R. (1998). *The tree of knowledge: The biological roots of human understanding.* Boston: Shambhala.

May, T. (2012). Why the word 'career' has become obsolete. *Computerworld.* Retrieved 2/22/2013 from http://www.computerworld.com/s/article/9234728/Thornton_A._May_Why_the_word_career_has_become_obsolete.

Moursund, D. (2010). *All educators are engaged in the scholarship of teaching and learning.* IAE Blog. Retrieved 2/12/2013 from http://i-a-e.org/iae-blog/all-educators-are-engaged-in-the-scholarship-of-teaching-and-learning.html.

Moursund, D. (2010). *An intact human brain is naturally curious and creative.* IAE Blog. Retrieved 3/11/2013 from http://i-a-e.org/iae-blog/an-intact-human-brain-is-naturally-curious-and-creative.html.

Moursund, D. (2008). *Communicating in the language of mathematics.* IAE-pedia. Retrieved 2/21/2013 from http://iae-pedia.org/Communicating_in_the_Language_of_Mathematics.

Moursund, D. (2011). *Computational thinking.* IAE-pedia. Retrieved 2/27/2013 from http://iae-pedia.org/Computational_Thinking.

Moursund, D. (2011). *Declining level of student creativity.* IAE Blog. Retrieved 3/11/2013 from http://i-a-e.org/iae-blog/declining-level-of-student-creativity.html

Moursund, D. (2011). *Information overload and underload.* IAE-pedia. Retrieved 2/21/2013 from http://iae-pedia.org/Information_Underload_and_Overload.

Moursund, D. (2012). *Scholarship/Science of Teaching and Learning.* IAE-pedia. Retrieved 2/12/2013 from http://iae-pedia.org/Scholarship/Science_of_Teaching_and_Learning.

Moursund, D. (2012). *Some history about computer literacy.* IAE-pedia. Retrieved 12/10/2012 from http://iae-pedia.org/Some_History_About_Computer_Literacy.

Moursund, D. (2/27/2012). *Supersized online courses.* IAE Blog. Retrieved 2/12/2013 from http://i-a-e.org/iae-blog/all-educators-are-engaged-in-the-scholarship-of-teaching-and-learning.html.

Moursund, D. (2012). *Two brains are better than one.* IAE-pedia. Retrieved 2/27/2013 from http://iae-pedia.org/Two_Brains_Are_Better_Than_One.

Moursund, D., & Ricketts, R. (1988). *Long-range planning for computers in schools.* Eugene, OR: International Society for Technology in Education. This book includes the initial collection of goals of education developed by Moursund and Ricketts. Over the years, this list has been updated several times. The version in this current IAE book represents considerable refinement of the original list.

Next Generation Science Standards. Retrieved 1/13/2013 from http://www.nextgenscience.org/.

PARCC: Partnership for assessment of readiness for college and careers. Retrieved 2/23/2013 from http://www.fldoe.org/parcc/.

Partnership for 21st century skills. Retrieved 1/13/2013 from http://ww(n.d/). w.p21.org.

Perkins, D., & Salomon, G. (1992). *Transfer of learning.* Contribution to the *International Encyclopedia of Education.* 2nd ed. Oxford: Pergamon. Retrieved 11/3/2012 from http://learnweb.harvard.edu/alps/thinking/docs/traencyn.pdf.

Phys.org (1/26/2011). *Number of Internet users worldwide reaches two billion.* Retrieved 10/25/2012 from http://phys.org/news/2011-01-internet-users-worldwide-billion.html.

SBAC: Smarter Balanced Assessment Consortium. Retrieved 2/23/2013 from http://www.smarterbalanced.org/.

Sylwester, R. (2012). The beginning search for an appropriate education. In *Creating an appropriate 21st century education.* Eugene, OR: Information Age Education. Retrieved 2/2/2013 from http://i-a-e.org/downloads/doc_download/243-creating-an-appropriate-21st-century-education.html.

Sylwester, R., & Moursund, D. (2012). *Creating an appropriate 21st century education.* Eugene, OR: Information Age Education. Free download available at http://i-a-e.org/downloads/doc_download/243-creating-an-appropriate-21st-century-education.html.

The Atlantic. A new kind of problem: The Common Core Math Standards. See http://www.theatlantic.com/national/archive/2012/11/a-new-kind-of-problem-the-common-core-math-standards/265444/.

The Elementary Science Study. See http://www.nap.edu/openbook.php?record_id=4966&page=124.

The Science Curriculum Improvement Study. See http://american-education.org/1974-science-curriculum-improvement-study-scis.html/.

The values clarification movement. Education Resources Information Center. See http://www.eric.ed.gov:80/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=EJ169012&ERICExtSearch_SearchType_0=no&accno=EJ169012.

Wikipedia (n.d.). *NETS for students.* Retrieved 11/23/2012 from http://en.wikipedia.org/wiki/National_Educational_Technology_Standards - NETS_for_Students.

Zhao, Y. (2/7/2012). Mass localization for improving America's schools. *Kappa Delta Pi Record.* Retrieved 2/23/2013 from http://www.tandfonline.com/doi/abs/10.1080/00228958.2012.654714.