Education for Students' Futures

David Moursund, Editor

Robert Sylwester, Editor

Publisher: Information Age Education: Eugene, Oregon, USA. See http://iae-pedia.org/.

Email: David Moursund at moursund@uorgon.edu.

Email: Robert Sylwester at bobsyl@uoregon.edu.

Contents

Front Matter

Editors

David Moursund, Editor and Author

David Moursund is an Emeritus Professor of Education at the University of Oregon, and co-editor of the IAE Newsletter. 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). IAE provides free online educational materials via its *IAE-pedia, IAE Newsletter, IAE Blog,* and books. See http://iae-pedia.org/Main_Page#IAE_in_a_Nutshell.

Email: moursund@uoregon.edu.

Robert Sylwester, Editor and Author

Robert Sylwester is an Emeritus Professor of Education at the University of Oregon, and co-editor of the *IAE Newsletter.* His most recent books are *A Child's Brain: The Need for Nurture* (Corwin Press, 2010), *The Adolescent Brain: Reaching for Autonomy* (Corwin Press, 2007), and co-authored with David Moursund: *Creating an Appropriate 21st Century Education* (IAE, 2012), *Common Core State Standards for K-12 Education in America* (IAE, 2013), and *Consciousness and Morality: Recent Research Developments* (IAE, 2013). He wrote a monthly column for the Internet journal *Brain Connection* during its entire 2000-2009 run.

Email: bobsyl@uoregon.edu.

Contributing Authors, in Alphabetical Order

Eamon Campbell

Eamon Campbell is a therapy assistant at Organization for Research and Learning (ORL), a private practice in the Seattle area that provides behavior services for Autistic children. He has a Masters Degree from the University of Washington in Special Education with an emphasis in Behavior Analysis, and is a Board Certified Behavior Analyst (BCBA).

Email: eamonsc@gmail.com.

Marcus Conyers

Marcus Conyers is cofounder of the nonprofit Center for Innovative Education and Prevention and author of several books, including *Positively Smarter: Using Educational Neuroscience to Increase Happiness, Achievement, and Well-Being* (in press with Wiley), *Five Big Ideas for Effective Teaching: Connecting Mind, Brain, and Education Research to Classroom Practice* (Teachers College Press, 2013), and *Innovating Minds: Using Educational Neuroscience to Increase Creative Thinking Skills* (in process with Wiley), and will be developing the website InnovatingMinds.org as a free resource to support educators in fostering creative thinking skills globally. He is the developer of the IDEA process for cultivating creative thinking skills and is a co developer with Donna Wilson of curriculum for graduate programs with majors in Brain-Based Teaching at Nova Southeastern University.

Email: marcus@ciep.org.

Doug Gleave

Doug Gleave served as superintendent of staff development and superintendent of schools in Saskatoon, Saskatchewan for twenty-three years. He was awarded a Ph.D. by the University of Oregon. He continues write professional articles for interest and possible publication. However, most of his time is spent with his six grandchildren.

Email: douggleave@outlook.com.

Spencer Kagan

Spencer Kagan is an internationally acclaimed researcher, presenter, and author of over 100 books, chapters, and journal articles. He is a former clinical psychologist and full professor of psychology and education at the University of California. He is the principal author of the single most comprehensive book for educators in each of four fields: cooperative learning, multiple intelligences, classroom discipline, and classroom energizers. Dr. Kagan developed the concept of structures; his popular brain-based, cooperative learning, and multiple intelligences structures like Numbered Heads Together and Timed Pair Share are used in teacher-training institutes and classrooms world-wide.

Email: spencer@kaganonline.com.

Linda Rappel

Linda Rappel is a certified teacher in the province of Alberta and a Sessional Instructor in undergraduate and graduate programs in education at the University of Calgary. She has a Doctor of Education degree in Adult and Workplace Learning and has been involved in adult language instruction for over twenty years.

Email: lrappel@shaw.ca.

Sean Sylwester

Sean Sylwester recently graduated from South Eugene High School. He has long been interested in computer games. He will begin a major in Electrical Engineering at Oregon State University this fall, with a focus on the technologies involved in simulations and video gaming.

Email: sean.sylwester@gmail.com.

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.

Acknowledgements

Thanks to the authors who contributed so generously of their works.

Thanks to readers who provided written and oral feedback.

Thanks to Ken Loge for his technical publishing support.

Thanks to Ann Lathrop for her editing assistance.

Part 1. The Concept of External Cognition

Informal and formal instruction has historically involved verbal and print interaction. Electronic wireless communication including social media have emerged within the past few years, and we can expect that technological advances in these fields will further affect educational policy and practice.

We are all familiar with the Industrial Revolution and what has traditionally been called the Industrial Age. The Industrial Age ended and the Information Age officially began in the United States in 1956. Chapters 2 and 3 refer to the Industrial Age and the Information Age as the First Machine Age and the Second Machine Age.

The Second Machine Age has brought with it rapidly increasing technological advances. There are some who forecast that eventually computers will become "smarter" than humans, and refer to this as the Technological Singularity.

1. David Moursund. Introduction.
2. David Moursund. The First Machine Age.
3. David Moursund. The Second Machine Age.
4. David Moursund. The Coming Technological Singularity.
5. David Moursund. Education for the Coming Technological Singularity.

Chapter 1

IAE Newsletter - Issue 132, February, 2014

Introduction

David Moursund
Emeritus Professor of Education
University of Oregon

> "The longest journey begins with the first step." (Chinese proverb.)
>
> "Ignorance is merely a condition of lacking knowledge. It is cured by education." (Unknown.)

The unifying theme of this futures-oriented book is forecasting and understanding possible educational changes that have the potential to significantly improve education. Changes might be in content, teaching processes, assessment, or some other aspect of education.

You probably remember the song:

> When I was just a little girl,
> I asked my mother, "What will I be?
> Will I be pretty? Will I be rich?"
> Here's what she said to me.
>
> "Que sera, sera,
> Whatever will be, will be,
> The future's not ours to see,
> Que sera, sera,
> What will be, will be."

A beautiful song. However, if we can accurately forecast the future, we can take actions both to prepare ourselves for it and to possibly change it.

Here is an example of educational challenges brought on by technology change. A little more than 5,000 years ago reading and writing were invented. This can be thought of as a technological development. During the past 5,000 years we have developed additional technology that helps support reading and writing, and we have developed teaching methods that make universal literacy feasible. The printing press is an excellent example of such technology.

The Internet and Web can be thought of as examples of technology that build on and greatly enhance reading and writing. Texting, with its cryptic messages and abbreviations, is certainly a challenge to our educational system. The easy integration of pictures, video, and sound into text, with delivery via the Web, is another technological challenge to our educational system. As a personal example, I thoroughly enjoy being able to quickly access dictionary definitions and Web articles for new words and ideas I encounter when reading online. This has certainly changed reading for me.

What the Future Is Bringing Us

For a number of years, the *IAE-pedia* has included annual series of brief summaries of articles focusing on What the Future is Bringing Us. The articles tend to be business oriented, but some include potential applications to education. Here is one example.

IBM recently published its annual five-year forecast for technological changes (*Relaxnews,* 12/17/2013). Quoting from the article:

> IBM said that its annual forecast of five ways technology will change lives in the coming five years was "driven by a new era of cognitive systems where machines will learn, reason, and engage with us in a more natural and personalized way."

Education is one of the five topics covered in IBM's forecast. IBM foresees "classrooms of the future" equipped with systems that track and analyze each student's progress to tailor an individualized curriculum and help teachers target learning techniques. Quoting again from the article:

> "Basically, the classroom learns you," IBM vice president of innovation Bernie Meyerson told AFP. "It is surprisingly straight-forward to do."

The forecast is saying that we have the knowledge and technology to greatly individualize instruction. Years of research in computer-assisted learning have led to the current "computer tutor" forms of Highly Interactive Intelligent Computer-assisted Learning (HIICAL) systems. We know what can be done with HIICAL, and we are making significant progress in this technological enhancement of instruction. The forecast is that we will make even more rapid progress in the near future.

IBM's forecast then goes on to list specific applications of the steadily increasing artificial intelligence of computer systems. In essence, there are many complex problems that people and our societies face, and computer technology can help to address these problems.

Responding to the Challenge

There is one major issue missing from IBM's education forecast. If a computer can solve or greatly help in solving a category of problems, what do we want our schools to help students learn about this category of problems? It is easy to forecast that we will make progress in individualizing instruction. But, will we make progress in significantly changing the content of the curriculum?

This is a very challenging question, because there are so many stakeholder groups involved in the curriculum content issue. As adults, we function in an open book, open computer, open connectivity environment that includes a steadily increasing collection of powerful computerized tools that help us at work, at play, and in other "authentic" daily tasks. Most of the assessment systems used in our current educational systems are not authentic. Quoting Grant Wiggins, a world leader in the field of authentic assessment:

> Assessment is authentic when we directly examine student performance on worthy intellectual tasks. Traditional assessment, by contract, relies on indirect or proxy 'items'—efficient, simplistic substitutes from which we think valid

> inferences can be made about the student's performance at those valued challenges (Wiggins, 1990).

Will the next five years see significant movement towards authentic assessment in which students are provided with the same types of computer tools as adults routinely use in their jobs?

Some Examples of Futures-oriented Topics

This section contains a few examples of topics that were designed to help potential authors to determine whether they might want to write for this newsletter series and subsequent book. Some of these topics are covered in the chapters that follow, and some remain as interesting, challenging questions. Readers who would like to add a chapter to this current book—covering one of the topics listed below that is not adequately covered in the book, or covering a topic they believe should be in the book—should contact one of the editors David Moursund or Robert Sylwester.

Education Begins in the Home

We know that a great deal of a child's education occurs in his or her home and comes from parents, guardians, close relatives, caregivers, siblings, and friends. As we make progress in improving the overall education of our population, we also improve the informal home education environments, and thus we improve the education of children.

We know that a successful policy of universal education and of providing every home with aids to education (such as making printed and electronic books readily available) leads to improvements in education. Via research we can compare and contrast this approach with one of providing all homes with easy access to entertainment-oriented television, Web-based audio/video, electronic games, and social networking connectivity. Which approach best supports improvements in our current educational systems? Is the wave of electronic technology entertainment helping or negating progress in universal education?

With these, as with many other aspects of informal and formal education, we can ask, "What does the research show?" What can we do to better and more broadly implement those changes in home environments that the research shows will improve our educational systems?

Changing Cultures

For thousands of years, a child grew up in a small clan or tribe, and assimilated the culture of this small group. Gradually, populations increased, travel became easier, and the "size" of a particular cultural group grew. Now we have cultural groups whose membership dominates an entire country or region of the world, and also constitutes a significant percentage of the population of many other countries.

In addition, we have new types of cultural groups made possible by computer technology. Social networking provides a good example. Facebook's membership is more than a seventh of the world's total population. Through Facebook and other social networks, a person may have dozens, hundreds, or thousands of "friends."

We also have computer game cultures. Some networked computer games have millions of players immersed in the culture of a particular game. For players who are deeply immersed, the game becomes a part of their culture and everyday life.

In brief summary, many children are now growing up to be multicultural in the traditional definition of a culture, and also multicultural in terms of participating actively in multiple social networks and gaming networks worldwide. How does and/or should this affect our educational system?

Individualization of Instruction

Since the earliest development of reading and writing, a small number of students have had the advantage of individual tutors. This one-on-one mode of teaching and learning is the "gold standard" of education.

As our societies made the decision to educate a much larger percentage of their children, schools were developed in which an individual teacher taught classes of a large number of students. This is much less expensive than providing each student with one or more tutors. However, it also is much less effective.

We now have the technology to provide students with "computer tutors." A computer tutor has some characteristics of a human tutor, and it can provide a great deal of individualization. At the current time, many schools are providing students with a mixture of human-based teaching in classes of 20 to 40 or more students, combined with more individualized computer-based instruction. The computer-based instructional systems are becoming better and more available. What does the future hold for very individualized Highly Interactive, Intelligent Computer-assisted Learning (HIICAL) (Moursund, 2015)?

Empowering Students

This theme focuses on ways students might take more responsibility for their own education. This includes helping students become skilled in: a) using the broad range of technology-based aids to learning on their own, and b) setting and achieving personal learning goals and gaining skills in self-assessment of progress toward achieving these goals. Empowering students includes developing safeguards to prevent their "gaming the system" by cheating and finding other ways that students try to avoid the kind of "good" learning that leads to increased levels of expertise, transfers to other disciplines, and transfers to the future.

Globally Oriented Education

Through improvements in transportation and communication, the world is growing "smaller." Our students need to be prepared for adult life in which there is worldwide competition for jobs and businesses. In a "smaller" world, people need to deal with ethnic, religious, cultural, and language diversity. They need to effectively participate in human efforts to deal with global problems such as: a) health and medicine; b) sustainability; c) over-population; d) global warming; e) civil wars and wars between countries; f) poverty; g) an increasing shortage of fresh water; and h) crimes against humanity and other violations of international laws.

Final Remarks

We are living at a time in which the pace of change of our formal schooling system is not keeping pace with the pace of changes in the world. There is a growing schism between the world that students face outside of school and the world they face in school.

References

Moursund, D. (2015). *Technology and problem solving: PreK-12 education for adult life, careers, and further education.* Eugene, OR: Information Age Education. Available as a free download: Microsoft Word file from http://i-a-e.org/downloads/free-ebooks-by-dave-moursund/266-technology-and-problem-solving-in-prek-12-education.html. PDF file from http://i-a-e.org/downloads/free-ebooks-by-dave-moursund/267-technology-and-problem-solving-in-prek-12-education-1.html. Web: http://iae-pedia.org/Technology_and_Problem_Solving.

Relaxnews (12/17/2013). IBM sees five tech-powered changes in next five years. *Yahoo News*. Retrieved 12/20/2013 from http://news.yahoo.com/ibm-sees-five-tech-powered-changes-next-five-090614295.html.

Sylwester, R., & Moursund, D., eds. (August, 2012). *Creating an appropriate 21st century education*. Eugene, OR: Information Age Education. Available as a free download: PDF file from http://i-a-e.org/downloads/doc_download/243-creating-an-appropriate-21st-century-education.html. Microsoft Word file from http://i-a-e.org/downloads/doc_download/242-creating-an-appropriate-21st-century-education.html.

Wiggins, G. (1990). The case for authentic assessment. *Practical Assessment, Research & Evaluation*. Retrieved March 14, 2015 from http://PAREonline.net/getvn.asp?v=2&n=2.

Suggested Readings from IAE

Moursund, D. (2014). Artificial intelligence. *IAE-pedia*. Retrieved 2/26/2014 from http://iae-pedia.org/Artificial_Intelligence.

Moursund, D. (9/5/2013). Educating students for their possible futures. *IAE Blog*. Retrieved 2/26/2014 from http://i-a-e.org/iae-blog/entry/educating-students-for-their-possible-futures.html.

Moursund, D. (2/16/2013). General educational goals in the United States. *IAE Blog*. Retrieved 2/26/2014 from http://i-a-e.org/iae-blog/entry/general-educational-goals-in-the-united-states.html.

Moursund, D. (12/26/2012). Predictions about the future of computer technology. *IAE Blog*. Retrieved 2/26/2014 from http://i-a-e.org/component/easyblog/entry/predictions-about-the-future-of-computer-technology.html?Itemid=58.

Chapter 2

IAE Newsletter - Issue 136, April, 2014

The First Machine Age

David Moursund
Emeritus Professor of Education
University of Oregon

> "In medicine, law, finance, retailing, manufacturing, and even scientific discovery, the key to winning the race is not to compete against machines but to compete with machines." (Brynjolfsson and McAfee, January, 2012.)

Our informal and formal educational systems help to prepare students for their possible futures. The design and implementation of curriculum content, instructional processes, and assessment in our schools build on our knowledge of what has worked well and what has not worked well in the past. We teach reading, writing, and arithmetic (math) to all students because of their enduring value over the centuries and our **guesses and predictions** that these will continue to be important in the future.

Guesses and predictions, "Aye, there's the rub." When the people and societies in our world were changing quite slowly, the future was much like the past. So, there was little need to make significant educational changes from generation to generation.

But now we live in a time when our educational system is faced by major technological changes that are occurring during relatively short periods of time. For example, during the early part of my career a good desktop calculator cost several thousand dollars and was not very portable. Now, a much better calculator is very portable and much less expensive. While fifty years ago it made no sense to integrate calculators into the precollege math curriculum, now it is commonplace to do so. Educators now argue about when to introduce calculators into the math curriculum, and whether doing so damages the overall math education of students.

Eric Brynjolfsson and Andrew McAfee are economists at the Massachusetts Institute of Technology. They have recently published *The Second Machine Age* (2014). Their book is about the Information Age (the Computer Age), how it is changing the world, and what we can do about it. See the videos McAfee (June, 2013) and McAfee (September, 2012) for a summary of the key ideas covered in the book.

In this chapter, I briefly summarize some of the authors' insights into how technology has changed the world in the past and how it is changing the world much more rapidly now. Their book contains a careful analysis of where we are now, and how we got here. It then goes on to make guesses and predictions about future developments. I think the information in this book should be integrated into the general education that all students receive. It will help them to understand the world as it is now, and how it will change substantially during their lifetimes.

I believe that Brynjolfsson and McAfee have provided us with a number of quite good (accurate) guesses and predictions, and I discuss several of them in this newsletter. In the next *IAE Newsletter* I will focus on some educational challenges and choices based on their guesses and predictions.

A Question to Ponder

Brynjolfsson and McAfee ask, "What have been the most important developments in human history?" This is a challenging question, and the authors briefly explore many different answers.

What do you think? Perhaps it was the development farming a little over 10,000 years ago—moving us from the Hunter-Gatherer Age into the Agricultural Age. How did the development of farming change the average quality of life? As you ponder this question, include the fact that horses and oxen were domesticated about 8,000 years ago. Farming is a very physically demanding life style, and it took 2,000 years before horses and oxen took on some of the physical labor. Farming changed very slowly over thousands of years.

You might want to focus on the plow, a very important technological development in farming. The history of the plow provides interesting evidence of how slowly change occurred during the Agricultural Age. Quoting from History of the Plow:

> The farmers of George Washington's day had no better tools than had the farmers of Julius Caesar's day; in fact, early Roman plows were superior to those in general use in America eighteen centuries later.
>
> …
>
> The first real inventor of a practical plow was Charles Newbold, of Burlington County, New Jersey, who received a patent for a cast-iron plow in June, 1797. However, early American farmers mistrusted the plow. They said it "poisoned the soil" and fostered the growth of weeds.

Perhaps you believe that the most important development was the invention of reading and writing about 5,000 years ago. During most of the past 5,000 years, few people learned to read and write. It is only in relatively recent times that our educational system has decided that universal literacy is highly desirable—that all children should go to school and learn reading, writing, and arithmetic.

Other ideas that might occur to you include the development of various religions or the development of various forms of government. For example, Democracy as a form of government, and its empowerment of the people, certainly was a "game changer." Think about how long it has taken to give voting rights to the broad masses of citizens.

In their book, Brynjolfsson and McAfee provide brief discussions of these types of historical events that have had long-lasting impacts. They then devote the remainder of their book to discussing changes in technology and the impact of these changes on people today.

The First Machine Age

The steam engine was developed about 300 years ago. This eventually led to the start of the First Machine Age (usually called the Industrial Age). Brynjolfsson and McAfee argue that the steam engine was the most important technological development in human history up until that time. Quoting from the Wikipedia:

> The first commercial true steam engine using a piston was developed by Thomas Newcomen and was used in 1712 for pumping in a mine.
>
> In 1781 James Watt patented a steam engine that produced continuous rotative motion. Watt's ten-horsepower engines enabled a wide range of manufacturing machinery to be powered.

Notice that during the time span 1712-1781 the steam engine had only a modest impact on the people of the world. It can take a new technology a very long time to become widely adopted and to produce major worldwide changes.

Watt's steam engine was a major breakthrough. Ten-horsepower is approximately the equivalent of 50 "human-power." To be more precise, a healthy human can produce about .1 horsepower for a sustained period of time, and a trained athlete can produce about .3 horsepower over a sustained period of time. The average of these two rates of human physical productivity is .2 horsepower, and corresponds to a 10-horsepower engine doing the physical work of 50 humans. (See http://en.wikipedia.org/wiki/Horsepower.) It is easy to understand that this was a huge breakthrough. The Industrial Age had truly begun.

Over the next two centuries of the Industrial Age, the steam engine was followed by many other technological developments that have greatly enhanced the average human quality of life in the world. Examples of these developments include: the telegraph, telephone, audio and video recording and playback devices; radio and television; electrification, electric lights, electric motors; trains, cars, airplanes, and rocket ships; huge advances in our medical system; huge advances in the production, storage, and distribution of food; and so on.

Roughly speaking, these Industrial Age developments were aids to our physical capabilities. This is obvious in transportation and factory production. Audio and video communication over great distances added a new dimension to the repertoire of human physical communication capabilities.

The First Machine Age also brought us wide scale education. Sugata Mitra's *Thoughts on the Future of Learning* in the book you are now reading provides an interesting view of the development of schools in England and throughout the British Empire. Required school attendance and labor laws were developed to keep young children out of the factories and to meet the need for literate factory workers and clerks throughout the British Empire. The system of education that emphasized reading, writing, and arithmetic worked well for 200 years.

The Second Machine Age (the Information Age)

We are now about 60 years into the Second Machine Age (often called the Information Age). In 1956 in the United States, some researchers noticed that the number of people holding white-collar jobs had just exceeded the number of people holding blue-collar jobs. Aha, they said. This is a big change. We are no longer in the Industrial Age. Let's call this new situation the Information Age (Naisbitt, 1982).

While the Industrial Age focused on aids to human physical capabilities, the Information Age focuses on aids to human mental capabilities. These two general categories of aids to human capabilities are now being combined in robots.

Some people find the term *robot* frightening. So, let's begin with a simple example. An electronic digital calculator can do arithmetic, solve equations, perform statistical calculations, and draw graphs. Probably you do not find this to be very frightening. When a human using such a calculator tells the machine what task to perform, the calculator is robotic in its fast and accurate actions of carrying out the operations to complete the task.

A modern equation solving and graphing calculator increases the productivity of humans in a relatively limited area. In solving certain types of equations or graphing functions, a human and calculator working together may be a great many times as fast—and more accurate—than a human using only pencil and paper. Moreover, a modern calculator is so inexpensive and portable that a person can carry one in a pocket and use it occasionally throughout the day as needed.

Now, think about what happened as connectivity and personal computers became available. Smart phones, laptop computers, tablet computers, and other digital devices connected to the Internet can be thought of as types of robots. This technology greatly expands the number of problems that can be addressed by a human and machine working together.

As a simple example, while writing this chapter I can access the world's largest library. In a few minutes I can accomplish an information retrieval task that may previously have required many hours in physical libraries. In addition, this information is available 24/7 and can be especially valuable in the many geographic areas without access to large research libraries. In accessing the accumulated knowledge of the human race, my productivity might be increased by a factor of many thousands.

In a few short years we have gone from having no smart phones to a worldwide production of a billion such devices per year. The use of computer technology and robots in our manufacturing and distribution systems means that, if we wanted to, we could provide nearly every student in the world with a tablet computer that incorporates the features of a smart phone and a laptop computer. Our educational system is just beginning to come to grips with how such technology can facilitate major changes in curriculum content, instructional processes, and assessment. These and some related topics will be addressed in the next chapter.

References

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies.* New York: W.W. Norton.

Brynjolfsson, E., & McAfee, A. (January, 2012). Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy. *MIT Sloan School of Management.*

Retrieved 4/11/2014 from http://ebookbrowsee.net/brynjolfsson-mcafee-race-against-the-machine-pdf-d344680524.

McAfee, A. (June, 2013). What will future jobs look like? *TED Talks.* Retrieved 4/11/2014 from http://www.ted.com/talks/andrew_mcafee_what_will_future_jobs_look_like.

McAfee, A. (September, 2012). Are droids taking our jobs? *TED Talks.* Retrieved 4/11/2014 from http://www.ted.com/talks/andrew_mcafee_are_droids_taking_our_jobs.

Naisbitt, J. (1982). Megatrends: Ten new directions transforming our lives. NY: Warner.

Chapter 3

IAE Newsletter - Issue 137, May, 2014

The Second Machine Age

David Moursund
Emeritus Professor of Education
University of Oregon

> "Work saves a man from three great evils: boredom, vice, and need." (François-Marie Arouet, nom de plum Voltaire; French Enlightenment writer, historian, and philosopher; 1694-1778).

This is the second of two chapters based on *The Second Machine Age* by Eric Brynjolfsson and Andrew McAfee (2014). See the videos McAfee (June, 2013) and McAfee (September, 2012) for a summary of the key ideas covered in the book. The first newsletter focused on the First Machine Age (the Industrial Age) and changes it produced throughout the world.

The Industrial Age provided us with many tools that supplemented our muscle and other physical abilities. Our current educational system is a direct product of changes brought about by the early years of the Industrial Age.

Changes in the Job Market

This chapter focuses on the Second Machine Age (often called the Information Age). We are now nearly 60 years into the Information Age. Humans continue to develop better aids to their physical capabilities, and are making very rapid progress in developing brain tools as aids to their metal capabilities. We now live in a world with global transportation and communication systems that facilitate distribution of the results of physical and brain work around the world. This is producing a worldwide competition for jobs.

Moreover, computers continue to gain in their artificial intelligence and physical capabilities. Jobs that used to require considerable manual dexterity, strength and stamina, intelligence, and education are being taken over by computers.

In many other jobs, a computer and a person working together can far outperform a person working alone. For example, I remember many years ago when the cost of a computer workstation designed for doing computer graphics first decreased to about $200,000. Many thousands of these machines were sold—because it was economically beneficial to companies to provide certain quite skilled workers with such a machine in order to increase their productivity.

A company's profits were increased by providing certain of its workers with a $200,000 computer! Now much more powerful computers are a hundred times cheaper. In the economically developed countries such as the United States, nearly every worker who can benefit by having access to a personal computer now has such access.

Worldwide, hundreds of millions of workers have become more productive because they can routinely make use of a computer, and many of these are connected to the Internet.

A Thought Experiment

Albert Einstein used the concept of thought experiments to help people understand some of his ideas about relativity. The next two paragraphs provide a somewhat modified version of the thought experiment that Brynjolfsson and McAfee (2014) use to illustrate what is happening in the job market.

> Think about a robot that has the physical and mental abilities to do the same work as a human. Suppose that a human who is doing this job receives wages and benefits that total $16 per hour, and that the robot can do the same job for a cost of $15 per hour. This $15 per hour covers the full costs, including maintenance, repair, periodic updates, and replacement after it wears out. Then in this particular job situation, some human workers will be displaced by robots. Others may take a decrease in wages so that they remain competitive with such robots.
>
> Now, suppose that a new type of robot comes on the market that costs only $5 per hour, and is still more versatile and productive than the first type of robot. Few workers will be willing to work for $5 per hour—an amount far below the U.S. Federal minimum wage. Such a robot will displace many millions of workers.

This direct displacement of workers is just now beginning to happen in the economically developed countries throughout the world. Brynjolfsson and McAfee present information about a robot named Baxter that costs only $4 per hour. It is quite versatile and can easily be taught new tasks. Click here to see a video showing Baxter in action.

Current Impacts of the Information Age

The previous chapter reported Brynjolfsson and McAfee's observation that the Industrial Age took many years to have a worldwide impact. Similarly, it has taken a great many years for the Information Age to reach a level that is significantly changing the world. These years have now passed, and the pace of change is accelerating even more rapidly. "You ain't seen nothin' yet" is a good summary of the changes that are occurring.

As economists, Brynjolfsson and McAfee are particularly interested in the adage, "follow the dollar." Quoting from their 2014 book:

> "Between 1983 and 2009, Americans became vastly wealthier overall as the total value of their assets increased. However, as noted by economists Ed Wolff and Sylvia Allegretto, the bottom 80 percent of the income distribution actually saw a net decrease in their wealth. Taken as a group, the top 20 percent got not just 100 percent of the increase, but more than 100 percent…. [Indeed,] between 2002 and 2007, the top 1 percent got two-thirds of all of the profits from growth in the U.S, economy."

People like to summarize this situation by saying that the rich got richer and the poor got poorer. This is a quite misleading statement. The quality of life of the average poor person in the U.S. has improved substantially. Think about the advances in medicine, as polio, smallpox, and measles have been nearly wiped out in the U.S. Think about the free availability of access to the Internet and Web in schools, libraries, and "hot spots" throughout the country. Think about free electronic games that run on quite inexpensive handheld devices.

In another analysis of this situation, Brynjolfsson and McAfee (2014) note that during the Industrial Age, and continuing until about 1995 in the United States, the Gross Domestic Product (GDP) grew very substantially. The percentage of the GDP paid to wage earners remained constant. That is, as the GDP increased more rapidly than the workforce, workers grew wealthier. With the exception of times of depression, employment levels were relatively stable over a period of 200 years. Many economists came to believe that all we needed to do to create new jobs and help the poor move out of poverty was to continue to "grow" the GDP.

Beginning in about 1995, this long-held assumption has proven incorrect. For well-educated and highly skilled workers (for example, those with a college degree) employment and wages have continued to follow the long-held trend. But, on average, other workers have lost ground. Their "share" of the GDP has fallen significantly, the number of well-paying jobs available to them has decreased, and many of the fulltime jobs they previously held have become part-time jobs. This is a huge change in employment, and it is happening throughout the economically developed nations of the world.

Brynjolfsson and McAfee note that we are making good progress in having driverless cars and trucks, and that this will eventually lead to major changes in the trucking industry. They also discuss the current state of the art of natural language translation systems. These systems are now becoming accurate enough to provide useful translations of both text and voice input. Google currently provides free translation of text in about 70 languages. Computerized voice to voice translation has reached a useful level. The authors talk about the computer system Watson that excelled in the TV game show Jeopardy, and that eventually will become a routine aid to medical doctors. These, and many other changes, are on the horizon.

According to Brynjolfsson and McAfee, this trend will continue indefinitely into the future. As robots become more and more physically and mentally capable, they will displace more and more workers. This leaves the U.S. and many other countries with a major and growing problem. As noted in the quotation at the beginning of this newsletter, "Work saves a man from three great evils: boredom, vice, and need." What happens as more and more young people—even those with college degrees—are unable to find employment that pays a "family wage?"

Solutions

Brynjolfsson and McAfee (2014) discuss three aspects of problems being created by the Second Machine Age. In brief summary they believe:

1. The problems are growing slowly, and we understand the problems. Governments can take actions to ensure that all people in their countries

have a decent standard of living. With steadily growing productivity in a country like the U.S., there is absolutely no reason why so many children are growing up in poverty and so many older people are living in poverty. Current and future technologies can produce enough so that no one need live in poverty. Our methods of distributing goods and services need to change so that all people have a decent standard of living. Brynjolfsson and McAfee explore various ways this can be accomplished.

2. We can educate people so they can live happy, creative, meaningful lives independently of their level and type of employment. This reminds me of the many actors, artists, dancers, musicians, and other creative and performing artists whose real passion and joy in life does not come from their "day jobs." I am also reminded of the many retired people (including myself) who are not diminished by no longer having paid employment. Our days are filled by: communicating with and interacting with relatives and colleagues; volunteerism; travel; making use of telephones, television, the Internet and the Web; electronic and non-electronic games; reading; hobbies; and other interesting activities.
3. We can improve our educational system to better prepare workers to work with computers rather than to compete with them. The statement, "Computers are here to stay," now seems rather trite. A more modern statement is, "Intelligent, versatile robots are here to stay." Brynjolfsson and McAfee provide examples in which humans and computers working together can easily surpass computers or humans working alone.

Notice that two of the above statements focus on education. Currently in the U.S., many politicians and other leaders say that the goals of precollege education are to prepare students for jobs and to prepare them for college. To me, this seems far too restrictive. I like to think in terms of preparing these students for responsible, productive, and self-fulfilling adulthood—and lifelong learning for dealing with change.

Brynjolfsson and McAfee point out that there also are many current jobs that will not be much changed in the near future by computer technology. Their list includes carpenters, cooks, dentists, gardeners, home health aides, janitors, and repair people. Human teachers will continue to play an invaluable role in our informal and formal educational systems. Robots are still quite far from being able to provide many of the personal services that people provide for each other.

Education and Technology

Brynjolfsson and McAfee repeatedly emphasize the need for students to learn to work with computer technology rather than trying to learn to compete with it. Some of this learning is occurring via our informal educational system. Watch youngsters as they use their smart phones to access information, store information (including music and videos), communicate, broadly share their ideas, take and share digital still and video pictures, and so on. While many adults have kept pace with these youngsters in mastering this very rapid technological progress, many others have not.

Our precollege schools and systems of higher education are gradually adjusting to students of all ages having routine access to smart phones, computer tablets, laptops, electronic games, the Internet, and the Web. So far, however, they are having trouble appreciating Marshall McLuhan's statement, "The medium is the message" and his ideas about "global village." We have a long way to go before the average adult understands the concept of being a citizen of the world, that we live in a global village, and that computer technology is now ubiquitous and still rapidly improving.

Computer-based instruction provides an excellent example of a very significant coming change in our educational systems. By 1985, there had been enough research on computer-based instruction (computer-assisted learning, CAL) that meta-studies (studies of the published studies) were beginning to be done. Evidence was mounting on the effectiveness of this new aid to teaching and learning. Researchers and developers in the area of Highly Interactive Intelligent Computer-Assisted Learning (HIICAL) envision a future in which all students have routine access to modern CAL that provides individualized instruction and high quality formative assessment feedback to students in whatever areas they want to study.

Brynjolfsson and McAfee discuss Massive Open Online Courses (MOOCs) as an example of technology now being able to provide free or quite inexpensive coursework to the world. Imagine a future in which every student has a computer tablet and routine access to Highly Interactive Intelligent Computer-assisted Learning (HIICAL) MOOCs that cover the entire curriculum. Looking a little further into the future, what should education look like when many homes have a walking, talking, artificially intelligent robot that can serve as a child's companion, playmate, and tutor? What roles will parents and teachers play in raising and educating children? What informal and formal education is needed to appropriately educate parents and teachers for their changing roles?

Final Remarks

We are just at the beginning of the changes that will be brought about by the continued research, development, and broad use of computer technology. Brynjolfsson and McAfee discuss the bounties that this will bring to the people of the world. But, they also point out the likely continued growth in the inequalities between the very rich and the very poor. They point out the problems people and governments face as jobs become scarcer and unemployment and under-employment steadily grow.

The education that people need in order to cope with such changes is quite different from what most are receiving via our current formal educational systems. All of us need to have an understanding of these changes. And, all of us need to become engaged in educating ourselves and others to effectively deal with such changes.

References

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies.* New York: W.W. Norton.

Brynjolfsson, E., & McAfee, A. (January, 2012). Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy. *MIT Sloan School of Management*.

Retrieved 4/11/2014 from http://ebookbrowsee.net/brynjolfsson-mcafee-race-against-the-machine-pdf-d344680524.

McAfee, A. (June, 2013). What will future jobs look like? *TED Talks*. Retrieved 4/11/2014 from http://www.ted.com/talks/andrew_mcafee_what_will_future_jobs_look_like.

McAfee, A. (September, 2012). Are droids taking our jobs? *TED Talks.* Retrieved 4/11/2014 from http://www.ted.com/talks/andrew_mcafee_are_droids_taking_our_jobs.

Moursund, D. (5/1/2014). Hungry children—America's shame. *IAE Blog*. Retrieved 5/13/2014 from http://i-a-e.org/iae-blog/entry/hungry-children-america-s-shame.html.

Chapter 4

IAE Newsletter - Issue 157, March, 2015

The Coming Technological Singularity

David Moursund
Professor Emeritus, of Education
University of Oregon

> "Any sufficiently advanced technology is indistinguishable from magic." (Arthur C. Clarke; British science fiction author, inventor, and futurist; 1917-2008.)

This is the first of two chapters about the increasingly rapid pace of technological change going on in our world. It is a slight modification of the *IAE Blog* entry http://i-a-e.org/iae-blog/entry/the-coming-technological-singularity.html.

The term *technological singularity* refers to some time in the future when computers become much "smarter" than people. Right now the rate of technological progress is both large and increasing. We have artificially intelligent computer systems that are more capable than humans in certain limited areas. However, we still seem far from a time in which computer intelligence exceeds human intelligence over the broad range of human intellectual endeavors.

Technological Singularity

Quoting from the Wikipedia:

> The first use of the term "singularity" in this context was by mathematician John von Neumann. In 1958, regarding a summary of a conversation with von Neumann, Stanislaw Ulam described "ever accelerating progress of technology and changes in the mode of human life, which gives the appearance of approaching some essential singularity in the history of the race beyond which human affairs, as we know them, could not continue."

Irving Jack Good was a mathematician/cryptologist who worked with Alan Turing. He believed an ultra intelligent computer might be built before the end of the 20th century. Quoting from (Good, 1965):

> Let an ultra intelligent machine be defined as a machine that can far surpass all the intellectual activities of any man however clever. Since the design of machines is one of these intellectual activities, an ultra intelligent machine could design even better machines; there would then unquestionably be an "intelligence explosion," and the intelligence of man would be left far behind. Thus the first ultra intelligent machine is the last invention that man need ever make, provided that the machine is docile enough to tell us how to keep it under control.... It is more probable than not that, within the twentieth century, an ultra intelligent machine will be built and that it will be the last invention that man need make.

The idea of a technological singularity has been popularized by science fiction writer and mathematician/computer scientist Vernor Vinge (Vinge, 1993). Quoting Vinge:

> The acceleration of technological progress has been the central feature of this century. I argue in this paper that we are on the edge of change comparable to the rise of human life on Earth. The precise cause of this change is the imminent creation by technology of entities with greater than human intelligence.

Ray Kurzweil

Ray Kurzweil is a computer scientist and engineer who has written and talked extensively about the coming singularity. See the two videos (Kurzweil, 4/28/2009; Kurzweil 6/4/2014), and his book, *The Singularity Is Near* (2005). We are creeping up on the technological singularity. Here is a forecast from Kurzweil (6/4/2014):

> "Jeopardy" is a very broad natural language game, and Watson got a higher score than the best two [human] players combined. It got this query correct: "A long, tiresome speech delivered by a frothy pie topping," and it quickly responded, "What is a meringue harangue?" And Jennings and the other guy didn't get that. It's a pretty sophisticated example of computers actually understanding human language, and it actually got its knowledge by reading Wikipedia and several other encyclopedias.
>
> Five to 10 years from now, search engines will actually be based on not just looking for combinations of words and links but actually understanding, reading for understanding the billions of pages on the web and in books. So you'll be walking along, and Google will pop up and say, "You know, Mary, you expressed concern to me a month ago that your glutathione supplement wasn't getting past the blood-brain barrier. Well, new research just came out 13 seconds ago that shows a whole new approach to that and a new way to take glutathione. Let me summarize it for you."
>
> Twenty years from now, we'll have nanobots, because another exponential trend is the shrinking of technology. They'll go into our brain through the capillaries and basically connect our neocortex to a synthetic neocortex in the cloud providing an extension of our neocortex.

Many Are Concerned by the Technology Trend

Are you frightened by the concept of a technological singularity? Do you want the technological singularity to occur? If the technological singularity does occur, it certainly will disrupt humanity.

Stephen Hawking is one of Britain's pre-eminent scientists (Cellan-Jones, 12/2/2014). Quoting from this BBC article:

> Prof Stephen Hawking, one of Britain's pre-eminent scientists, has said that efforts to create thinking machines pose a threat to our very existence.
>
> He told the BBC: "The development of full artificial intelligence could spell the end of the human race."
>
> …

> The theoretical physicist [Hawking], who has the motor neurone disease amyotrophic lateral sclerosis (ALS), is using a new system developed by Intel to speak.
>
> Machine learning experts from the British company Swiftkey were also involved in its creation. Their technology, already employed as a smartphone keyboard app, learns how the professor thinks and suggests the words he might want to use next.
>
> Prof Hawking says the primitive forms of artificial intelligence developed so far have already proved very useful, but he fears the consequences of creating something that can match or surpass humans.

Final Remarks

The possibility of a technological singularity is an interesting and challenging global problem. Kurzweil and others argue that it is inevitable. They argue among themselves about when it might happen, and they point to the rapid progress that is occurring. Hawking and others express fear of it happening, or argue that it will never happen. The naysayers argue that there are many aspects of a human being that can never be captured in a machine.

Certainly technological progress and the changes it is bringing to our world are a major and ongoing situation that is affecting all of us. Thus, a modern education should certainly include helping students understand the current and increasing pace of change in technology, how it is affecting them now, and how it will affect them in the future. As a teacher or parent, you can stay informed about major technological changes and share your insights with the students and others in your life.

References

Cellan-Jones, R. (12/2/1014). Stephen Hawking warns artificial intelligence could end mankind. *BBC News*. Retrieved 2/22/2015 from http://www.bbc.com/news/technology-30290540.

Good, I.J. (1965). Speculations concerning the first ultraintelligent machine. In *Advances in computers,* vol. 6, Franz L. Alt and Morris Rubinoff, eds. Academic.

Kurzweil, R. (6/4/2014). The hierarchy in your brain: Ray Kurzweil at TED 2014. *TED Talks.* Retrieved 2/23/2015 from http://www.kurzweilai.net/ted-ray-kurzweil-get-ready-for-hybrid-thinking.

Kurzweil, R. (4/28/2009). *The coming singularity.* (7:10 video.) Retrieved 2/23/2015 from https://www.youtube.com/watch?v=1uIzS1uCOcE.

Kurzweil, R. (2005). *The singularity is near. When humans transcend biology.* NY: Viking.

Vinge, V. (1993). *The coming technological singularity: How to survive in the post-human era.* Retrieved 2/22/2015 from http://mindstalk.net/vinge/vinge-sing.html. The original version of this article was presented at the VISION-21 Symposium sponsored by NASA Lewis Research Center and the Ohio Aerospace Institute.

Chapter 5

IAE Newsletter - Issue 158, March, 2015

Education for the Coming Technological Singularity

David Moursund
Emeritus Professor of Education
University of Oregon

> "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.)

This is the second of two chapters about our rapidly changing technology. The previous chapter introduced the idea of a technological singularity. The term technological singularity refers to some time in the future when computers become much "smarter" than people.

Right now the rate of technological change is both large and rapidly increasing. We have artificially intelligent computer systems that are more capable than humans in certain limited areas, and we have artificially intelligent robots that are taking over many jobs previously performed by human workers. However, we still seem far from a time in which computer intelligence and capabilities exceed human intelligence and capabilities over the broad range of human endeavors.

Remember, the current estimated life expectancy of today's precollege students is about 80 years. So, our current K-12 educational system is preparing students for what they will do during the 60 or more years after they leave high school. Think back over the changes our world has seen in the past 60 years. Now try to imagine what would constitute a good education for a future of 60 years of rapidly accelerating change. The next two sections provide my current insights and recommendations about this question.

Educational Implications: Foundational Ideas

This chapter is motivated by the (possibly coming) technological singularity, and our current high and accelerating pace of technological change. Our educational system is currently facing many other challenges, and they are not going away!

First, consider the current balance between a "past-oriented" and a "future-oriented" education. When the world was changing only slowly, a past-oriented education served us well. Adults could easily adjust to the very small number of Science, Technology, Engineering, and Mathematics (STEM) changes that occurred during their lifetime.

This slowly evolving educational system served humanity well even as reading, writing, and arithmetic were developed and very, very slowly were introduced to the masses. Most of the world's population remained illiterate for thousands of years after the development of these three "basics" of today's education.

Reading, writing, and arithmetic, along with oral communication skills, remain essential today. However, the technology-enhanced environment in which we perform these activities has changed. A modern and future-looking educational system prepares students to function well in our current "connected and computerized" world, and also lays a foundation that will help our future adults adjust to continuing rapid technological progress.

Second, consider aids to teaching and learning. Books were (and still are) a tremendous aid, as were audio and video recording and playback systems. All of these, and much more are available in today's state-of-the-art teaching machines. Such teaching machines are interactive and make effective use of modern technological aids to learning and doing reading, writing, arithmetic—and **thinking, problem solving, and communication.** *Technology and Problem Solving: PreK-12 Education for Adult Life, Careers, and Further Education* is a free short book that provides an overview of such teaching machines (Moursund, 2015).

Third, consider the idea of learning to work with computer technology rather than compete with it. What can human beings do well that computers cannot do or can only do quite poorly? We need to help all of our students better understand the intrinsic human characteristics that make us so different from computers.

We are a very long way from having computers that have the knowledge and skills of a caring, loving, human with well-developed and routinely used good "people skills." An increasing number of future jobs will go to job seekers who have well-developed "human" strengths and who can employ these strengths when working with robots and general-purpose computer systems.

Educational Implications: Specific Recommendations

Here is my current list of specific recommendations to students, parents, and others who are concerned about today's students getting a modern education. I am sure you can add to the list.

To begin, think about **what distinguishes people** from the machines and tools humans have developed as aids to their physical and mental capabilities. Perhaps words such as compassion, empathy, loyalty, tenderness, and spirituality come to mind. Perhaps you think about sharing feelings such as love, joy, happiness, sadness, fear, and anger. Some people have love-hate relationships with their car or computer, but these are not reciprocated from the tools back to the people.

So, here are some specific recommendations:

- Develop your "people" and communication skills. Become fluent in face-to-face, written, and computer communication skills. If you have the opportunities to do so, become bilingual and bicultural. Become a "people person" and a "citizen of the world."
- Focus your education on gaining higher-order, creative thinking, understanding, and problem-solving knowledge and skills in whatever areas you decide to study.

- Learn about current and near-term capabilities and limitations of computers and robots. Plan your education and develop your abilities so that you do not end up in head-to-head competition with computers and robots in areas that they are already quite good at and are getting better (Moursund, 2/11/2015; Boehm, 2/8/2014).
- Make very sure that you learn to make effective and fluent use of Information and Communication Technology (ICT), both in general use and in the discipline areas you choose to study. Remember, the combination of a human brain and a computer brain can often outperform either one working alone (Moursund, 2014).
- If you are "really into" computers, continue to develop your computer knowledge and skills, but also work toward gaining a high level of expertise in one or more other career fields. This will help prepare you for many of the new jobs that are being developed that require a combination of ICT and "traditional" knowledge and skills.
- Develop learning skills and habits of mind that will serve you throughout your lifetime. For example, learn about persistence along with the concepts of intrinsic motivation, reflection, and instant gratification (Moursund, 1/28/2014).
- Identify your specific physical and mental strengths and weaknesses as a learner and "doer" in each area that you study. Develop and exploit your strengths, and work to overcome your weaknesses.
- This final recommendation is specifically for students. Think about what you want in your future. What informal and formal education do you need to help ensure that you will achieve a decent quality of life? Remember the quote, "All work and no play makes Jack a dull boy." Make sure that you gain knowledge and skills that support possible avocations, hobbies, and other non-vocational aspects of your future.

How Fast Is Technology Changing?

The following chronological list captures billions of years of "intellectual" change. I find it helps me to think about the very slow pace of change for billions of years, and the increasingly rapid current and likely future pace of change.

1. Life on earth started with in the first simple cells and their genetic coding of information using RNA and later DNA. This began about 3.6. billion years ago. Within a hundred million years, multi-celled life forms developed. A DNA molecule stores the equivalent of about 1,000 books of data.
2. Over the next three billion years, more complex life forms developed. Life forms developed with a precursor to a brain of gradually increasing complexity to store and process information. By a half-billion years ago a basic ganglia structure existed in some animals, and this is considered to be a start of a brain. It provided information

storage that supplemented the DNA storage, and eventually evolved into our current mammalian brain.

3. The first primate-like animals developed about 65 million years ago. They were a product of well over three billion years of evolution. It was a mere 200,000 years ago that anatomically modern humans with our current brains developed. The storage capacity of a human brain is probably in the range of two million to two billion books. Our brains both store and process information. We both learn and forget.
4. A mere 5,200 years ago, writing and reading were developed by humans as aids to storing and retrieving information. We finally had long-term information storage that could easily be shared among many people and relatively accurately passed on from generation to generation. Libraries could grow in size and additional libraries could be built.
5. Less than 80 years ago, electronic digital computers were developed as aids to storing, processing, and retrieving information. A single "run" of the Large Hadron Collider produces about 30 petabytes of data—the equivalent of about 30 billion books. Today's fasted supercomputers can perform more than 100 million billion arithmetic computations per second. (Compare that number with how long it takes you to do a multiplication or division of two multidigit numbers.)

Photography, telephones, television, electronic storage and playback devices, and computers are all predecessors to today's Smartphone. The first commercially available telephone combining the concepts of intelligence, data processing, and visual display screens into telephones became available in 1993. Both in 2013 and in 2014, total worldwide production of Smartphones was about 1 billion per year—that is, about one for each person on earth in each of these two years.

The "smartness" of Smartphones is quite impressive and increasing year to year. Some of the smartness features are a Global Positioning System, a voice input and output system, and access to increasingly smart Web search engines. Some of the artificially intelligent smartness is built into a Smartphone, and some comes from access to and use of the steadily growing accumulation of human knowledge stored on the Web and in other digital libraries. That is, the Smartphones that people are buying right now continue to increase in capability and intelligence through progress in improving the smartness of devices outside of computers and improving the capabilities of the global communications network.

Final Remarks

Here are two quotes that capture the essence of this chapter:

> "We must welcome the future, remembering that soon it will be the past; and we must respect the past, remembering that it was once all that was humanly possible." (George Santayana; Spanish citizen raised and educated in the United States, generally considered an American man of letters; 1863-1952.)

> "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.)

What You Can Do

> "When you teach, you learn twice." (Seneca; Roman philosopher and advocate of cooperative learning; 4 BC-65 AD.)

Your knowledge, skill set, and insights make you different from every other person. As you interact with other people, you are both a teacher and a learner. As a teacher, you can help shape the future lives of many people.

Select a couple of the bulleted items in the Specific Recommendations section that seem particularly important to you. Bring these ideas up in discussions with your colleagues and students. Especially, share them with your students and engage them in thinking about how the ideas are being integrated into their current education. Listen carefully to—and learn from—their insights into what they believe would improve the education they are receiving.

References

Boehm, M. (2/8/2014). Job polarisation and the decline of middle-class workers' wages. *VOX Cepr's Policy Portal.* Retrieved 2/12/2015 from http://www.voxeu.org/article/job-polarisation-and-decline-middle-class-workers-wages.

Moursund, D. (2015). *Technology and problem solving: PreK-12 Education for adult life, careers, and further education.* Eugene, OR: Information Age Education. Available for free download: Microsoft Word file from http://i-a-e.org/downloads/free-ebooks-by-dave-moursund/266-technology-and-problem-solving-in-prek-12-education.html. PDF file from http://i-a-e.org/downloads/free-ebooks-by-dave-moursund/267-technology-and-problem-solving-in-prek-12-education-1.html. Web document: http://iae-pedia.org/Technology_and_Problem_Solving.

Moursund, D. (2/11/2015). Robots are here and lots more are coming. *IAE Blog.* Retrieved 2/14/2015 from http://i-a-e.org/iae-blog/entry/robots-are-here-and-lots-more-are-coming.html

Moursund, D. (2014). Two brains are better than one. *IAE-pedia.* Retrieved 2/11/2015 from http://iae-pedia.org/Two_Brains_Are_Better_Than_One.

Moursund, D. (1/28/2014). Good learners. *IAE Blog.* Retrieved 3/1/2015 from http://iae.dreamsteep.com/index.php/iae-blog/entry/good-learners.

Part 2: Cognition Begins with Attention

Learning always begins with attention, so it is not surprising that brain scientists and educators have studied attention for many years. Learning occurs within one's brain. This is an ongoing process when awake or asleep, and throughout life.

There are many demands on a person's conscious attention. Historically, survival depended on paying attention to the information brought in through our senses. The difference between life and death might depend on hearing the sounds or smells of a predator, or heeding the warnings of a parent or others.

Advances in electronic technology such as computers, Smartphones, and games, have added substantially to the demands on a student's attention. Our schools and their teachers often find themselves competing with the new demands for students' attention.

6. David Moursund. Self-assessment Can Help Students to Become More Responsible for Their Own Education.
7. David Moursund. Mastery Learning and Authentic Assessment.
8. Robert Sylwester & Eamon Campbell. Attention in an Increasingly Distractive World.
9. Eamon Campbell. Developing Abilities to Cope with and Reduce Distraction
10. Spencer Kagan. The Problem Is Not the Cell Phone.
11. Doug Gleave. The Administrative Role in Interactive Instruction.

Chapter 6

IAE Newsletter - Issue 133, March, 2014

Self-assessment Can Help Students to Become More Responsible for Their Own Education

David Moursund
Emeritus Professor of Education
University of Oregon

> "Don't worry about what anybody else is going to do.... The best way to predict the future is to invent it. Really smart people with reasonable funding can do just about anything that doesn't violate too many of Newton's Laws." (Alan Kay; American computer scientist; 1940-.)

When you think about possible improvements in our various educational systems, what do you wish for? Are your wishes carefully considered, grounded in reality, and achievable? Alternatively, perhaps some of them might raise a note of caution described by the idiom, "Be careful what you wish for, lest it come true."

Alan Kay, who is quoted above, helped pioneer the development of a number of important aspects of the field of computer and information science (CIS), including laptop computers. See http://iae-pedia.org/Alan_Kay. He and other CIS pioneers made forecasts about what could occur in the future of the field, and then went ahead and did the work to make their forecasts prove to be reasonably accurate.

This chapter discusses one of my educational wishes and the topic of self-assessment.

My Wish

I wish that our informal and formal educational systems would do much better in helping students to take greater personal responsibility for their own education.

This sort of wish is a good conversation starter. But, notice how imprecise it is. Here are some examples of questions that need to be explored to help clarify my wish.

1. Suppose we consider an individual student. Can we measure how much personal responsibility this student takes for his or her informal and formal education? Are our measurements sufficiently accurate so that we can measure progress over a period of days, weeks, months, or years? Do we have carefully research-based interventions that have a reasonable probability of increasing this student's level of assuming responsibility? Who might take responsibility for implementing such interventions and carefully monitoring the results?
2. What evidence do we have that education will be improved by our educational systems making progress toward achieving my wish? What money, time, and other resources will it take to make this progress? Where will the needed

resources come from? Are there better ways to use these resources—better, in terms of improving our educational systems?

3. What am I able and willing to do to help make my wish come true?

Usefully Accurate Forecasts

We all know that education is not an exact science. From my point of view, the more science-like a discipline is, the more accurately experts in the discipline can forecast its future. We know a great deal about the rotation of the earth on its axis and its orbiting the sun. Astronomers can quite accurately forecast the time of sunrise and sunset at a particular location on earth years in the future.

Weather forecasting is less science-like than these aspects of astronomy. However, weather forecasters make usefully accurate forecasts. That is, over time many people find weather forecasts accurate enough to be useful.

In terms of the book you are now reading, we are hoping to develop usefully accurate forecasts and plans about significantly improving our educational systems and helping the forecasts to be achieved. This chapter illustrates what the editors have in mind.

Information and Communication Technology (ICT)

Throughout my career I have seen the steady growth in the power and availability of ICT. It has been easy to accurately forecast this change over the years. See http://i-a-e.org/iae- blog/entry/moore-s-law-and-improving-education.html. For more information about the science of forecasting, see Moursund (2010). For forecasts made 50 years ago by two brilliant science fiction authors, Isaac Asimov and Arthur C. Clarke, see Colman (1/1/2014) and Kelly (9/4/2011).

I have long believed that this steadily improving ICT would eventually be thoroughly integrated throughout school curriculum content, instructional processes, and both formative and summative assessment in ways that would improve the quality of education our students are obtaining. While some progress has occurred, the progress has been slow and we have a very long way to go.

In summary, I can forecast changes in technology with reasonable accuracy, and I can wish for technology-based changes in our educational system. If my wishes are not too far misaligned with my forecasts, then I can do productive work to make my wishes come true, and I can solicit the help of others in making my wishes come true.

However, will education be improved by progress toward fulfilling my wish? Quoting from Shakespeare's *To be or not to be* soliloquy in Hamlet:

> To die, to sleep;
>
> To sleep, perchance to dream: ay, there's the rub...

It is easy to propose—and to wish for— possible solutions to a problem. However, it is another thing to have solid research that provides strong evidence that the proposed solution will actually work.

Physical and Mental Self-assessment

A very young child who is just beginning to crawl does not do a conscious self-assessment of his or her crawling style, speed, and endurance. The child does not make conscious comparisons with other children. The same observations hold for initial learning of oral communication, walking, self-feeding, and so on. Increasing capabilities in these and many other areas result from innate drives, mediated by innate capabilities and encouragement from older people.

A young child does not consciously analyze his or her current physical and mental capabilities and growing capabilities, and then make decisions to do better. A child's parents, guardians, doctors, teachers, and other caregivers encourage and support the types of progress that they believe is appropriate. Their skills in diagnosis, teaching, and childcare are critical to a child's physical and mental development.

Gradually, however, a child gains increased self-awareness and can assume an increased level of personal responsibility. Good teaching and role modeling (via parenting and childcare, peer instruction, members of the child's extended community, preschool, school, and social networking) make a huge difference both in a child's physical and mental progress, and in a child learning to take increased personal responsibility for some of this progress.

Assessment and Instruction

To measure change (in this case, progress), we need baseline data and then regular monitoring of changes. Suppose, for example, I decide that I do not read as rapidly and with the level of comprehension that I would like. There are free self-assessment instruments available on the Web. See http://iae-pedia.org/Self-assessment_Instruments#Reading_Speed_and_Reading_Comprehension.

In addition, there are many websites that provide instruction designed to increase reading speed and comprehension. My recent Google search of *increase reading speed and comprehension free* produced nearly 230 thousand hits. See, for example, http://en.wikipedia.org/wiki/Speed_reading.

This provides an excellent example to support my wish. Reading is an important part of education. I want each student to take increased responsibility for his or her reading speed and comprehension. I want the student to ask:

1. Are my current reading speed and comprehension adequate to meet my current personal needs?
2. Are my current reading speed and comprehension adequate to meet the needs/desires of key stakeholders such as my parents, teachers, and the school system?
3. Am I making appropriate progress toward achieving a level of reading speed and comprehension that will serve my personal foreseeable needs in the future, in my possible roles as a responsible adult, parent, and employee?

Schools, the Web, and many other resources are available to help the student. But it is the student who must put in the time and effort needed to become a better reader. It is the student who personally gains the benefits of becoming a better reader or who suffers the consequences of being a poor reader. Some students learn to consciously make this effort, and others don't.

Access to Free Self-assessment Instruments

The Web is by far the world's largest library. As children learn to read, and to make responsible and effective use of this library, they gain access to immensely valuable resources.

I am particularly interested in free self-assessment instruments and accompanying materials designed to help a person gain increased levels of expertise in the areas being assessed. My current collection of such materials is available in an *IAE-pedia* article at http://iae- pedia.org/Self-assessment_Instruments. I encourage my readers to send me links to other self- assessment instruments that can be accessed at no cost on the Web. I will be pleased to add these to the *IAE-pedia* article.

Final Remarks

I am reminded of a conversation I once had with an expert on early childhood. She told me about helping four- and five-year-olds learn to think about their thinking—that is, to learn reflection and metacognition techniques. I am also reminded of the research and practice of helping Head Start children learn to pay attention and to focus their attention.

Work on metacognition, attention, and other key ideas such as "think before you act" illustrates that our increasing level of research-based knowledge and practice in these areas can be usefully incorporated into our early childhood education. Gaining knowledge and skills in these areas helps to provide a foundation for students to become more responsible for their own education.

As children grow toward physical and mental maturity, they develop the capacity to take more and more responsibility for their own physical and mental wellness and growth in these areas. Each of us can help students to develop enduring habits of mind in these endeavors.

References

Colman, D. (1/1/2014). Isaac Asimov predicts in 1964 what the world will look like today—in 2014. *Open Culture*. Retrieved 1/4/2014 from http://www.openculture.com/2014/01/isaac-asimov-predicts-what-the-world-will-look-in-2014.html.

Kelly, K. (9/4/2011). Arthur C. Clarke predicts the future in 1964...And kind of nails it. Open Culture. Retrieved 1/4/2014 from http://www.openculture.com/2011/09/arthur_c_clarke_looks_into_the_future_1964.html.

Moursund, D. (11/8/2007). *Planning, forecasting, and inventing your computers-in-education future.* Eugene, OR: Information Age Education. Available as a free download: Microsoft Word file from http://i-a-e.org/downloads/free-ebooks-by-dave-moursund/24-planning-forecasting-and-inventing-your-computers-in-education-future-1.html. PDF file from http://i-a-e.org/downloads/free-ebooks-by-dave-moursund/24-planning-forecasting-and-inventing-your-computers-in-education-future-1.html.

Moursund, D. (n.d.). Self-assessment. *IAE-pedia*. Retrieved 3/9/2014 from http://iae-pedia.org/Self_Assessment.

Moursund, D. (n.d.). Self-assessment instruments. *IAE-pedia*. Retrieved 3/9/2014 from http://iae-pedia.org/Self-assessment_Instruments.

Chapter 7

[IAE Newsletter - Issue 135, April, 2014]

Mastery Learning and Authentic Assessment

David Moursund
Emeritus Professor of Education
University of Oregon

> "Through learning we become able to do something we never were able to do. Through learning we re-perceive the world and our relationship to it. Through learning we extend our capacity to create, to be part of the generative process of life." (Peter Senge; American scientist and director of the Center for Organizational Learning at the MIT Sloan School of Management; 1947-.)

I have enjoyed the writings of Grant Wiggins for many years. This chapter draws heavily from Wiggins' recent article, Getting Students to Mastery: How Good Is Good Enough? (Wiggins, December, 2013/January, 2014). His discussion of mastery learning includes a strong emphasis on using authentic assessment to determine a learner's level of mastery.

Wiggins begins his article on mastery learning by using the following definition from the online edition of the *Oxford English Dictionary*:

> MASTERY: An action demonstrating or involving great skill or power…to perform a notable deed or wonderful feat. Consummate skill, ability, or accomplishment.

According to this definition, the key idea is performing notable actions that demonstrate and/or involve great skill or power. This emphasis on performance is similar to a key aspect of project-based learning (PBL). A PBL project leads to a product, performance, or presentation (Moursund, n.d.).

Mastery

Recently I watched the Winter Olympics. I marveled at the performances of athletes who exhibit a very high level of mastery in their particular events. They have achieved this level of mastery through perhaps 10,000 or more hours of practice under the tutelage of well-qualified coaches, and they have a high level of natural ability.

I was particularly taken by the world-class ice skaters. Not only had they mastered a number of different skating elements, they had also mastered stringing a long sequence of elements into a graceful, artistic, emotion-laden performance set to music.

However, when we talk about mastery learning, we certainly do not expect young students to perform at a world-class level. This leaves us as educators with the challenge of defining what constitutes mastery in a manner that is appropriate over a huge range of performance areas and for learners with different levels of physical and mental development. It also leaves us with the issue of natural ability. **To what extent should a definition of mastery take into consideration a student's physical and mental natural abilities?**

Historically, the idea of mastery learning goes back at least a hundred years (Dewey, 1916; Bloom, 1968, 1971). But these early writers did not provide solid definitions and measures of mastery. Thus, individual states, school districts, schools, and teachers were left to create and implement their own definitions and measures.

Mastery Learning Today

Over the years, mastery has come to mean a specified level of performance on exams. Quoting again from Wiggins (December, 2013/January, 2014):

Numerous writers on and practitioners of mastery learning, for example, propose that mastery be set locally as a percentage score on any test. Thus, if you achieved 85 percent or 90 percent on any test of content, you would be deemed to have demonstrated mastery—no matter how picayune or low-level the test questions.

…

And that's where it stands today. Many schools that call themselves mastery-based (or proficiency-based or competency-based) are using invalid and unjustified schemes for giving scores and accolades. Rather than designing backward by establishing complex, worthy, and valid tasks on which students must demonstrate high-level ability (Wiggins & McTighe, 2005), schools too often reduce mastery to a high grade on a simplistic and nonvalidated assessment.

Wiggins attributes major flaws in our current educational system to the lack of a suitable definition of mastery learning. He notes:

> Perhaps as a result of the lack of an overall vision for what constitutes mastery, education has a long-standing practice of turning worthy learning goals into lists of bits. One might even say that this practice is the original sin in curriculum design: Take a complex whole, divide it into small pieces, string those together in a rigid sequence of instruction and testing, and call completion of this sequence "mastery." Although well intentioned, this practice leads to needlessly fractured, boring, and ultimately ineffective learning that never prepares students to be fluent and skilled in authentic work.

I consider this to be one of Wiggins' most powerful observations. In our efforts to improve education, we have broken the curriculum into innumerable small pieces that we teach and then test students for mastery. Some students are able to put the pieces together in a comprehensive and authentic, useful whole—but the majority cannot. Many in the latter group of students may well pass all of the tests at a designated "mastery level" (such as a B grade) but be utterly unprepared to deal with the related authentic challenges they will face in higher education and outside of school.

Where Wiggins Would Like Education to be Headed

Wiggins and McTighe (2005) have proposed a definition of mastery they believe will promote discussion and help improve authentic, mastery learning.

> Mastery is **effective transfer of learning in authentic and worthy performance**. Students have mastered a subject when they are fluent, even creative, in using their knowledge, skills, and understanding in key performance challenges and contexts at the heart of that subject, as measured against valid and high standards.
>
> Thus, **effective transfer of learning, done with creativity, polish, and grace, is the essence of mastery**. Mastery is not just technical knowledge. … You haven't mastered a subject if you only possess skills and facts in isolation and can only produce them on demand in response to prompts. Mastery must be tested using authentic tasks and scenarios at the heart of "doing" the subject. And instruction for mastery must be designed backward from these corner stone tasks. [Bold added for emphasis.]

The emphasis is on performance in authentic, worthy tasks. Quoting Wiggins from The Case for Authentic Assessment (1990):

> Assessment is authentic when we directly examine student performance on worthy intellectual tasks. Traditional assessment, by contract, relies on indirect or proxy 'items'—efficient, simplistic substitutes from which we think valid inferences can be made about the student's performance at those valued challenges.
>
> Do we want to evaluate student problem-posing and problem-solving in mathematics? experimental research in science? speaking, listening, and facilitating a discussion? doing document-based historical inquiry? thoroughly revising a piece of imaginative writing until it "works" for the reader? Then let our assessment be built out of such exemplary intellectual challenges.

In his 2013/2014 article, Wiggins uses the Common Core writing standards as an example of where schools should be headed. The Common Core anchor standards in writing (National Governors Association Center for Best Practice & Council of Chief State School Officers, 2010) specify that students should:

- Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
- Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
- Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

Notice four things:

1. These are writing performance activities that require higher-order analysis, synthesis, and evaluation.
2. Both the teaching of writing at this level and the assessment of writing at this level require very well-qualified teachers and individualized feedback.

3. It takes many years of study and practice to develop the needed level of mastery of the various elements of writing and to combine them to meet the high standards that are being proposed. Indeed, I suspect that many college or university graduates might have difficulty in meeting these proposed standards.
4. There are a great many jobs and other adult-level tasks that do not require such a high level of writing skill.

Final Remarks: How Do Computers Fit into This?

Here is a definition of lower-order that I use when trying to emphasize the changes being wrought by Information and Communication Technology (ICT).

> If a computer or computerized machinery can solve a type of problem or accomplish a type of task, then the problem or task is lower-order.

My point is that lower-order and higher-order need to be defined within an environment that includes the mind tools that humans have developed. ICT (including artificially intelligent computers and robots) has changed the world. Many problems and tasks that once were physically and mentally challenging are no longer so. Using voice input or a keyboard to tell a warehouse robot to get a particular item and deliver it to a shipping station requires neither higher-order thinking nor a high level of education.

In this warehouse setting, an employer wants to hire an honest, reliable worker who can consistently and accurately perform the order-processing task throughout a work shift. An authentic measure of the education of such a person would focus on things such as being able to learn to do a new lower-order job, work ethic, reliability, ability to get along with people (such as fellow employees), reading, keyboarding and/or using a voice input system, and so on. Notice that none of these activities require having learned high school algebra and geometry, or being able to write at the level of the writing standards discussed earlier.

This situation reminds me of my youth in Oregon, when physically fit young men could get a relatively well-paying job working in the lumber industry. Employers were looking for a combination of brawn and brains that bore little relationship to what these young men were experiencing in school.

Most of these lumber industry jobs have disappeared, but there still exist a large number of entry-level low-paying jobs in other areas. Many employers include "high school graduate" in their requirements and screening processes. They are looking for the habits of mind, reliability, punctuality, and stick-to-itiveness associated with successfully completing high school, rather than any specific knowledge and skills learned in the process.

My conclusion is that these characteristics are an important area of authentic mastery learning that need greater emphasis in our informal and formal educational systems.

References

Bloom, B. (1968). *Learning for mastery. Evaluation comment 1(2).* Published by the UCLA Center for the Study of Evaluation and Instructional Programs.

Bloom, B. (1971). Mastery learning. In J. Block, ed. *Mastery learning: Theory and practice*. New York: Holt, Rinehart, and Winston.

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York: MacMillan.

Moursund, D. (2013). Education for increasing expertise. *IAE-pedia*. Retrieved 2/23/2014 from http://iae-pedia.org/Education_for_Increasing_Expertise.

Moursund, D. (n.d.). Project-based learning. *IAE-pedia*. Retrieved 3/16/2014 from http://iae-pedia.org/Project-Based_Learning.

National Governors Association Center for Best Practices & Council of Chief State School Officers (2010). *College and career readiness anchor standards for writing*. Washington, DC: Authors. Retrieved from http://www.corestandards.org/ELA-Literacy/CCRA/W.

Wiggins, G. (December, 2013/January, 2014). Getting students to mastery: How good is good enough? *ASCD Educational Leadership*. Retrieved 2/16/2014 from http://www.ascd.org/publications/educational-leadership/dec13/vol71/num04/How-Good-Is-Good-Enough%C2%A2.aspx.

Wiggins, G. (1990). The case for authentic assessment. *Practical Assessment, Research & Evaluation*. Retrieved March 14, 2015 from http://PAREonline.net/getvn.asp?v=2&n=2..

Wiggins, G., & McTighe, J. (2005). *Understanding by design*. Expanded ed. Alexandria, VA: ASCD.

Chapter 8

IAE Newsletter - Issue 138, May, 2014

Attention in an Increasingly Distractive World

Robert Sylwester
Emeritus Professor of Education?
University of Oregon

Eamon Campbell
Therapy Assistant
Organization for Research and Learning

This chapter explores the central roles that attention plays in cognition in our evolving culture and in our changing educational systems. Research into our attention systems has made remarkable progress in the past couple of decades. While some of the research has been integrated into our schooling systems, much remains to be done.

This and the next three chapters will (1) provide a functional description of how our attention system works and (2) suggest how to reduce the distracting attentional elements of recent communication devices in our increasingly overloaded culture. They will suggest educational techniques that are designed for students with attention disorders and for regular classroom students who are distracted by cell phones and other portable communication devices.

Emotion and Feelings

Emotion is an unconscious system that identifies variations from normality (sounds, smells, etc). The renowned emotion researcher Antonio Damasio uses the term feelings to represent a conscious perception of what's occurring during emotional arousal. Feelings can thus bias the direction of an emotional arousal (1999).

Emotion activates our attentional system, which identifies the nature and location of the variability. Attention then activates memory, thought, and problem solving systems—and finally a behavioral response emerges. Attention is thus a cognitive gateway, leading to a cognitively based response.

In these four chapters about attention and distractions, we are mainly interested in individual people. However, a group, organization, corporation, government, or the world can also attend to a potential problem situation, and may be distracted from doing so. The people running clothing stores pay attention to trends in clothing styles and forecasts of an exceptionally cold winter or hot summer, and provide merchandise to fit their customers' needs. Stores that are distracted from such foresightful behavior tend to lose customers. The problem of global warming has caught the attention of many of us, but the cognitive processing capabilities of national governments and many global organizations leave much to be desired. Politics can be a major distracter.

A Cultural Shift in Attention

Smart phones and other easily portable communication technologies have become integral and important to our everyday lives, but they create an attentional problem. It seemed like a good idea initially to insert the names of everyone we know into our wireless social media devices since we would thus have constant access to each other. What happened, however, has become an attentional dilemma. Even if we don't want to immediately interact with someone, we still have to decide whether or not to respond to the phone ringtone or vibration. We have to stop attending to what we are currently attending to, and make a decision as to whether to immediately attend to the phone. (We may attend to it by turning it off!)

Email and the Web spawned social networks. Facebook is now the largest of these, with over a billion participants from throughout the world.

Young people especially were initially enthralled. Interacting with relatives, friends, and acquaintances near and far seemed neat. And it is wonderful to get caught up in the moment of something fascinating and then to share it with *friends* (a concept that social media have now redefined). Alas, one's social media friends may not be as fascinated as we were by seeing what our restaurant meal looks like. Social media participants soon realized that they were getting a lot more information than they really wanted to have—but they still couldn't get their eyes off their hand-held devices. Many of us get a level of immediate gratification from such things as receiving messages, sending messages, and playing fast-paced electronic games.

Family and friends had taught us about good manners, but they tended to focus more on one-to-one and small group interactions and not on the complexities that cell phone and social media present. To be able to use the wireless devices to contact 911 or a tow truck on the rare occasions when they're needed is now overshadowed by constant messages about the often inane. It's no longer simply about one-to-one conversation but messages are increasingly sent to everyone on the list. The average adolescent receives and sends about 100 messages a day.

And as if that isn't enough, an increasing number of TV cable channels, computer websites, and electronic games also seek our attention. Attention does indeed play an increasingly central gate-keeping role in just about everything we do.

The Basics of Attention

The mental maladies that people confront throughout their life, from the possibility of an autistic beginning to an Alzheimer's ending, are often attentional disorders at some level. Inattention similarly leads to automobile accidents, classroom misbehavior, marital strife, and a whole lot more. Effective attention is thus central to a high quality of life, and most people achieve it (at least most of the time).

Michael Posner's analysis of the underlying neurobiology of attention (2007) is widely accepted. He identified three functionally separate networks that regulate attention: (1) the alerting network prepares us to receive new information and to maintain a necessary level of alertness, (2) the orienting network shifts our current focus to something deemed possibly more important, and (3) the executive attention network draws heavily on memory to recognize the identity of the new challenge (foreground), determine its significance, and then to separate it from background information (which it then merely monitors or ignores). Since it's often not clear whether a challenge is a danger or opportunity, or which of several current challenges is most important, this temporary holding network (commonly called our working brain) is critical to the resolution of such ambiguities. A dysfunctional executive network may attempt to solve the wrong problem, or to solve problems it doesn't understand. This error occurs at all levels, from within individual brains to the sets of interacting brains that constitute a company or government.

Such factors as our current temperament and local environment can affect our attention, thought, and consequent behavior. We thus differ in our attentional preferences, and in our capacity to regulate attention. What an odd world it would be if we were all culturally and cognitively cloned, with the same interests and abilities. The individual differences in attention that we confront are challenging, but to complain about them is like a custodian complaining that the floors are dirty. Human variability defines life.

The Dilemmas of Attention

To recapitulate, emotion alerts our attention system to potential dangers and opportunities. Attention then identifies the time/space elements of the challenge so that we can rationally determine how best to respond. When we're too focused on a specific element of a challenge, we might miss some other element that's important. When we spread our attention over multiple environmental elements, we might consider something as peripheral when it's actually very important. It's not surprising that the terms *tunnel-vision* and *scatterbrain* are conceptually embedded within our mind.

From Noise to Signal. Daniel Goleman's book (2013) focuses on the dilemmas caused by increased technologically-driven attentional demands, many of which are mitigated by how our brain processes multiple attentional dilemmas, such as those identified above. A growing concern is that we're moving towards a time in which our interactions will increasingly flow through machines, and we'll begin to lose such important evolutionary capabilities as the ability to read the facial expressions and gestures that are significant in developing comprehension and empathy.

We have long used visual (reading, writing) and auditory (phones, radio) formats that didn't require face-to-face communication. What has now changed is the rapid development and widespread use of cell phones and related social networking communication media. Cell phones now also allow for face-to-face interaction.

The Loss of Context. The relentless demands of portable devices that seek attention to things at a distance means that we lose a sense of what's happening here and now.

The onslaught of digital information leads to a loss of context through such shortcuts as determining the nature of the message by the heading, rapidly skimming messages, and ignoring voice mails. These kinds of shortcuts reduce the time we need to reflect on the information we receive or on our possible responses that we often shorten so they in turn will be attended to.

We get frustrated by the complexities of cultural problems so we often seek opinion-oriented venues (such as FOX, MSNBC, and related websites) to provide us with biased news and commentary. The search for pundits who suggest how we should think keeps us from having to think for ourselves and thus to possibly change our perspectives.

Machine Solutions to Machine Problems. Although we may want to discuss a problem with a human being, we can anticipate an increased reliance on machine-driven communication. We all experience this when we try to contact a business and are asked to respond to a series of recorded questions driven by the buttons we press.

New technologies are fortunately emerging to solve current and developing problems. When folks became concerned that an unflattering picture would forever follow them via social media, Snapchat and similar venues emerged. Take and send a picture, and those who receive it get only a few seconds to see it before it's permanently removed from their device. See http://mobile.businessweek.com/articles/2013-02-07/snapchat-and-the-erasable-future-of-social-media.

The Search for Biological Solutions. Humans historically are good at developing and using new technologies. We formerly had a long time to do this before the next major technological arrival, but the current rapidity of change is staggering. Still, mastering technologies is something that most (but not all) young people seem to do well.

The next two chapters describe how educators can help students with severe attentional disorders and those in regular classrooms to function appropriately with potentially distracting communicative devices.

References

Damasio, A. (1999). *The feeling of what happens: Body and emotion in the making of consciousness.* New York: Harcourt.

Goleman, D. (2013). *Focus: The hidden driver of excellence.* New York: Harper.

Posner, M.I., & Rothbart, M.K. (2007). *Educating the human brain.* Washington, D.C.: American Psychological Association. Abstracts of the book and its 10 individual chapters are available online at http://psycnet.apa.org/psycinfo/2006-12927-000.

Chapter 9

IAE Newsletter - Issue 139, June, 2014

Developing Abilities to Copewith and Reduce Distraction

Eamon Campbell
Therapy Assistant
Organization for Research and Learning

Robert Sylwester
Emeritus Professor of Education
University of Oregon

The previous chapter focused on attention and on technologies that distract us from paying attention. It suggested that portable social media devices such as cell phones have become an increasingly disruptive force in social settings, with the recipients' curiosity about the sender now competing with the their current attentional focus.

I (Eamon Campbell) work individually with children who have serious attentional disorders. I help them learn how to effectively master attention, and avoiding distraction is thus an important part of my assignment. In this chapter I'll describe interventions designed to help the children I work with develop appropriate behavior with communication devices. Since the children I work with also attend regular preschool or elementary classrooms, special education teachers and teachers who work with normally developing students may find some of the ideas and techniques useful. The next article in this series will suggest specific strategies with social media devices that are more closely designed for students who attend only regular classrooms.

Distractible Objects and Easily Distractible Children

Some children are unable to sustain their attention for an extended period, seemingly flitting from one thing to another. They may be unable to focus on the task at hand because they're focused on a different current stimulant in their environment.

As a therapist, my instructional task is to get an easily distracted child to attend to a task without being distracted from it. Over time I work to extend what initially is a typically short attentional time frame. In this endeavor, reinforcement is an essential instructional tool. Success itself should be the intrinsic motivation, but special needs children often need such additional reinforcement as food or access to some preferred object or activity to continue to maintain focused attention. Praise and awards also provide a useful secondary level of reinforcement, but the goal is to eventually make success with the task itself as the intrinsic motivation.

Objects or anything else that shifts attention away from the learning task tend to create a problem. If a child prefers access to the object or activity but will temporarily act appropriately in order to get access to it, I'll use that situation to enhance on-task behavior. For example, one 10-year-old child wanted continued access to his iPad. I hid it while we were working together at a table because its presence was a distraction.

I then gradually inserted it into the setting along with a timer that alerts him that he has one more minute of time with his iPad before his instructional break is over and he then goes back to his assignment. When the timer sounds, I leave his iPad where it was but with the screen turned off as long as the iPad doesn't distract him from his assignment. The strategy works. He's now reached the point at which he can ignore his iPad while working on his learning task. If he tries to play with the iPad during work time, I quietly remove it from his field of vision and we resume working on the assigned learning task.

I've discovered that it's important for me to reinforce any independent decision he makes to avoid being distracted. For example, if he's fidgeting with an action figure instead of attending to me at the table, I'll stop talking and give him up to15 seconds of my silence to independently correct his behavior. My silence often prompts him to put the toy away and attend to me. Contrast this with a less effective approach such as, "Stop playing with that toy. Pay attention now, and I will give you two extra minutes of break time when we finish what we are doing."

An eventual lifetime goal of this type of intervention would be to get the student to determine which of several competing attentional goals is currently most important. For example, I want the student to learn to ignore a vibrating pocketed cell phone when he is talking with the folks he's met for dinner. The aphorism, "You can't chew gum and eat at the same time" comes to mind when considering this form of distraction.

Another type of example is a toddler who will work for Spiderman stickers. I don't show or mention them until we're ready to begin the activity, and then I indicate that he'll get one or more stickers if he meets certain behavioral criteria.

Suppose the lesson focuses on brainstorming imaginative ideas or creating story ideas. If the Spiderman stickers are in plain sight, they are apt to bias the toddler's ideas and the content of his conversation. Just seeing Spiderman stickers can thus limit a child from a task in which I'm seeking variability in response. So, I keep them out of sight. This kind of removal intervention is used reasonably often in special education teaching, because it helps to prepare children for the distractions of adult life.

In preschool, the toddler has learned strategies that help to focus his attention. The teachers taught him to orient his body towards the person he's communicating with because we're more inclined to attend to those we face. To support that strategy, I'll also arrange things so that he's not only facing the person he's working with (if he's working with a partner) but I'll also be sure that he has limited distracting stimuli behind his partner. The point is to physically eliminate anything that could distract the two from the learning task. Over time, I'll begin to add a distraction or two to build up their capability to deal with it.

Distractible People and Easily Distractible Children

Children with attentional disorders are often distracted by other people, especially by those who are engaged in another activity, are speaking to someone, or are just being nearby. When working with a child in a home environment, I try to use a quiet room and close the door. When I work with a child in a classroom, I initially use classroom screens or face the child away from visual distractions.

I also must consider how much distraction I really want to eliminate. Students need to be able to function in a natural environment with all of its social distractions. For example, if another student comes over and asks a question, I'll help the student I'm working with determine how best to respond—which can vary from a quick simple response to "I'm busy now. I'll tell you later." I then take the time to discuss the appropriateness of the response. Over time, I hope that the child will learn that responding/ignoring a cell phone bell tone or a question from a real person are two seemingly different situations that are actually similar. The important thing is to always consider the context.

Final Remarks

We humans have had many millennia to master such conventions of when to speak and when to interrupt. Children should grow up in a home, community, and school environment in which the adults know and understand these conventions. The children learn by imitation and by being corrected by the adults when they deviate from the standard conventions. It's a part of the nurturing process that young folks get.

Hand-held communicative devices add another dimension to this educational challenge. Many of today's adults have not yet learned to follow the cultural conventions that are being developed for cell phone use. For example, audiences are reminded to silence their cell phones at the beginning of performances. So, today's children are growing up in a home, community, and school environment in which many adults are poor role models of appropriate cell phone use conventions.

The children are thus explorers, often developing conventions that are commonly used within their group of friends and acquaintances. Parents and teachers must work with them to determine appropriate and best use of this amazing technology. Many young people have a better grasp of the communication technology than the adults they interact with, so the adults and children can learn from each other. The next article in this series will explore that situation.

Chapter 10

IAE Newsletter - Issue 140, June, 2014

The Problem Is Not the Cell Phone

Spencer Kagan
Executive Director
Kagan Publishing and Professional Development

Educators are complaining about surreptitious and even overt use of cell phone texting during class. The premise of this paper is that cell phone texting is not the problem; it is merely a symptom of a lack of highly engaging instructional strategies. In the absence of highly engaging external stimuli, students turn to alternative sources of stimulation: External (texting) or Internal (mind-wandering). Both of these alternative activities engage the social cognition network, the default network of the brain. By adopting highly interactive, engaging instructional strategies, we treat the disease, not the symptom. In the process we create greater liking for class, content, and teacher, and support proven acceleration of achievement.

In this chapter we explore: 1) How traditional instructional strategies fail to provide engaging external stimuli; 2) How non-engaging instructional strategies that fail to activate the social cognition network predictably lead to texting and mind-wandering; and 3) How texting and mind-wandering can be radically reduced or eliminated by adopting alternative instructional strategies that provide high levels of stimulation and activation of the social cognition network.

Traditional Instructional Strategies Lack Sufficient Stimulation to Prevent Texting and Mind-Wandering

I have now done workshops in 35 countries and have toured classrooms in those countries. In each country the dominant instructional strategy is Whole-Class Question-Answer (WCQA). During a lecture or presentation, in an attempt to produce active engagement the teacher stops presenting and asks the class a question. Students who feel they would like to answer raise their hands. The teacher then calls on one student to answer. After the student answers, the teacher responds to the answer, offering an acknowledgement, praise, an augmentation, or a correction.

This traditional instructional strategy sequence is bankrupt with regard to producing active engagement among students. The math of it reveals WCQA is exquisitely designed to produce disengagement. For example, in a class of only thirty students, if the teacher did no talking at all and wanted to give each student a minute to verbalize their thoughts, calling on students one at a time would take thirty minutes. In fact, during WCQA the teacher talks about half the time, first asking the question and then responding to the answer. Thus it takes about two minutes to allow one minute of active engagement per student. This means that during WCQA, if students in a class of thirty participate about equally, the maximum each student can talk is about one minute per hour. In fact, however, many students choose not to raise their hands so their active participation is zero minutes an hour! In larger lectures or if the lecturer chooses not to ask the class questions, the active engagement of students is far less than one minute per hour. Behavioral engineers could not design greater disengagement!

The lack of active engagement during instruction is particularly problematic because students have become accustomed to a very high level of stimulation. They have become accustomed to a steady diet of multimodal input including MTV, DVDs, YouTube, video games, and the Internet. The pace of stimulation has increased exponentially. To view, literally view, how the pace of stimulation has multiplied, simply watch a movie made thirty years ago. Everything moves slowly. We become bored, anticipating action that does not happen. So too is it with today's youth in a lecture. They are bored, having become accustomed to fast moving multi-media stimulation. Whereas yesterday's instructor could hold the attention of students with straight instructor talk (because that was the most stimulating game in town), today's instructors rarely can. Finding teacher talk boring, students seek alternative stimulation via texting and mind-wandering.

Texting and Mind-Wandering Result from Non-engaging Instruction

The predictable results of non-engaging instruction are texting and mind-wandering. To understand why this is so, we need to take a detour to understand the social cognition network in the brain, and to overview the research on mind-wandering.

The Brain's Social Cognition Network

Our brains have distinct neural tracks dedicated to figuring out the minds of others.

Contrary to what was believed for decades, new research demonstrates that brain structures involved in working memory and nonsocial reasoning are not involved in social cognition or *mentalizing*. Mentalizing is figuring out what someone else is thinking, feeling, or intending. The structures in the brain that are responsible for mentalizing are part of the social cognition network located mostly in the medial (midline) regions of the brain in contrast to the working memory and fluid intelligence structures which are located in the lateral (outer) surface of the brain. We have an entirely independent social cognition brain network![1]

> In other words, the neuroimaging findings are telling us something we could probably never have learned by just thinking about the inner workings of our minds: although social and nonsocial thinking feel like the same kind of process, evolution created two distinct systems to handle them.[2]

That this social cognition network is located in a deeper part of the brain indicates it evolved earlier. We are fundamentally social beings.

Social Cognition Is the Brain's Default Mode

The social cognition network is the brain's default network. When we are given IQ-type test questions or try to estimate how far our car can travel on the gas remaining in the tank, our working memory and fluid intelligence go to work, shutting down the social cognition network. Brain scans reveal that as soon as we have completed those tasks, our brains re-activate the social cognition network.[3, 4]

> The default network quiets down when we perform a specific task, such as calculating a math problem in math class or studying ancient Greek pottery in

history class. But when the mind's chores are done, it returns to Old Faithful—the default mode. In other words, the brain's free time is devoted to thinking socially.[5]

That the social cognition network is our default network means we are primed to look for thoughts, feelings, and intentions in others. We even extend this proclivity to impute feelings and intentions to objects. For example, when shown a motion picture of triangles, a circle, and an open box with the geometric figures moving, normal children and adults attribute feelings and intentions to the objects, "the big triangle is a bully that is picking on the small triangle and circle, who are running scared but then…."[6] Autistic children, who have a deficit in social cognition, describe the same objects and movements objectively. They do not impute feelings or intentions to inanimate objects: "the big triangle went into the rectangle. There were a small triangle and a circle. The big triangle went out. The shapes bounce off each other…."[7] Our normal default mode is to look for thoughts, feelings and intentions of others, and even attribute them to inanimate objects! Our default mode of cognition is social cognition. We are social creatures.

Social and non-social reasoning are carried out by different brain structures. Thinking about the academic content is carried out in an entirely different place in the brain than thinking about a girl's potential response to a request for a date! When subjects read sentences that do not involve figuring out what someone is thinking, feeling, or intending, the lateral prefrontal regions of the brain associated with language, working memory, and fluid intelligence become engaged. In contrast, across a number of studies, when subjects read sentences that involve mentalizing, thinking about the thinking of others, their social cognition network goes into action. The regions involved with working memory and fluid intelligence are quiet. The social cognition network consists of four structures: The dorsomedial prefrontal cortex (DMPFC), the tempoparietal junction (TPJ), the posterior cingulate, and the temporal poles.

These two distinct networks of brain structures actually work antagonistically.[8] Thinking about nonsocial, task-related content shuts down thinking about the thoughts, feelings, and intentions of others, and mentalizing shuts down thinking about nonsocial tasks. We have a social IQ and a task IQ, but we can't operate both at once!

The implication: We have a social brain distinct from our nonsocial brain! Knowing what others are thinking is so important that our brains dedicate special, independent circuits for that purpose.

Texting and Mind-Wandering

In the absence of compelling external content, the brain naturally turns to social cognition. Texting is a social activity. So too is mind-wandering: During mind-wandering we activate the social cognition network–our thoughts turn to understanding the thoughts, feelings, and intentions of others. Thus, both texting and mind-wandering are a predictable response to the non engaging format of WCQA. Given the lack of engaging external stimuli, the brain gravitates toward social cognition.

Pervasiveness of Mind-Wandering

Mind-wandering is variously referred to as "stimulus-independent thought (SIT),"[9] "task unrelated images and thoughts (TUIT),"[10] "task unrelated thought (TUT),"[11] "attention lapses,"[12] "zone outs,"[13] "daydreaming,"[14] "decoupling of attention from the external environment,"[15] and "Mind-Wandering."[16]

Numerous studies document the pervasiveness of mind-wandering:

- Among 2,250 adults randomly sampled during the day via an iPhone application, mind-wandering (attention to non task-related thoughts) occurred a remarkable 46.9% of the time![17]
- The iPhone application revealed mind-wandering occurs in all but one waking activity at least 30% of the time or more. The one exception: making love!
- A bell was sounded to sample mind-wandering during college classes and the researchers found minds wandering 54% of the time![18]
- Spontaneous mind-wandering occurs more often among college students with a childhood history of ADHD.[19]
- In a major review of mind-wandering research, the authors concluded, "mind-wandering may be one of the most ubiquitous and pervasive of all cognitive phenomena."[20] Their review of different approaches to measuring mind-wandering revealed mind-wandering occurs across a diverse variety of tasks between 15% and 50% of a person's time.

Using a clicker device to record mind-wandering during lectures, researchers found attention lapses to be early and frequent. They disconfirm the notion that minds only begin to wander after about 10 minutes into a presentation:

> Contrary to common belief, the data in this study suggest that students do not pay attention continuously for 10–20 minutes during a lecture. Instead their attention alternates continuously between being engaged and non-engaged in ever-shortening cycles throughout a lecture segment.
>
> ...
>
> Students report attention lapses as early as the first 30 seconds of a lecture, with the next lapse occurring approximately 4.5 minutes into a lecture and again at shorter and shorter cycles throughout the lecture segment.[21]

Additional research has disconfirmed the belief that attention declines only after ten to fifteen minutes into a lecture. Minds begin wandering right away! [22]

Mind-Wandering Lowers Achievement

Mind-wandering impairs achievement:

- Mind-wandering is related to decreased note-taking and performance on course exams.[23]
- Participants whose minds wander more, fail to notice when the text they are reading has turned to gibberish and continue reading for a significant number of words before realizing what they are reading makes no sense![24]

- Mind-wandering occurs about 20-40% of the time during reading, and those whose minds are wandering are often unaware they are off topic—they lack meta-cognitive skills.[25]
- Reading comprehension is lower for those whose minds wander more.[26, 27]

Experimenters measured mind-wandering in a lecture to 334 undergraduate students taking an introduction to psychology course.[28] During the fifty-minute lecture a bell rang at 8, 15, 25, 34, and 40 minutes into the lecture. Students recorded if they were focused on the lecture or on unrelated thoughts or images. Mind-wandering was associated with lower performance on mid-term and final exams and overall course grades. It was also correlated with lower overall academic performance. To the extent the mind is wandering, the lecture is not understood or retained.[29]

The negative relationship between mind-wandering and test performance is strong. Experimenters tested mind-wandering and test performance in three one-hour lectures, each with different content. Individuals were probed at intervals during the lectures to report if their minds were wandering. After the lecture was over, those who self-reported mind-wandering on fewer than 50% of the probes correctly answered 77% of the questions on lecture content; those who reported mind-wandering on more than 50% of the probes correctly answered only 54% of the questions.[30]

An Antidote to Texting and Mind-Wandering: Engaging Instructional Strategies

An antidote to both texting and mind-wandering is the use of engaging, cooperative instructional strategies that meet the need for demanding external stimulation and engagement of the social cognition network. Here I will briefly describe two of many such strategies that can be used during any lecture or presentation: *Listen Right!* and *Numbered Heads Together*. Details of these strategies are presented in two books: *Kagan Cooperative Learning*,[31] and *Brain-Friendly Teaching*.[32] Steps of additional highly engaging, interactive instructional strategies are available in over 100 books published by Kagan Publishing.[33]

Listen Right!

In contrast to traditional lectures in which students take notes *while* the teacher is talking, *Listen Right!* separates listening and note-taking. Students have full, undivided attention to a chunk of the lecture and undivided attention to note-taking. They are not attempting to take notes *while* listening to the next bit of the lecture, which results in impoverished listening and impoverished note taking. The social cognition network is activated as students share their notes with others and improve them via the interaction. The steps of the strategy are as follows:

1. Teacher presents a chunk of content.
2. Teacher stops presenting.
3. Students take notes, without interacting with other students.
4. Students share their notes with a partner or within their team, augmenting if a partner has included something important they have missed.

5. Teacher announces key points.
6. Students celebrate if they recorded key points.
7. Teacher presents next chunk and process is repeated.

Numbered Heads Together

In contrast to working alone, *Numbered Heads Together* is designed to have students "put their heads together" to encourage, support, and tutor each other at points during a lecture or presentation, activating the social cognition network. The steps of the strategy are as follows:

1. Students in teams of four each have a number, 1 through 4.
2. Teacher asks a question or poses a problem and allows think time.
3. Students privately write an answer.
4. Students stand and share answers with teammates, discussing and teaching each other.
5. Students sit when everyone knows the answer or feels prepared to share their thoughts.
6. Teacher calls a number, 1 through 4.
7. Students with that number stand, shows their answers via a slate, response card, or some other way.
8. Classmates applaud those with the right answer or with a differentiated response.

Listen Right! and *Numbered Heads Together* both engage the social cognition network and both provide a high level of engaging stimulation. Students engaged in these and other highly engaging, interactive instructional strategies have little time or inclination to text or to mind-wander. Research confirms the impact of engaging instructional strategies. In a series of independent research studies conducted by a research team at State University of New York (SUNY) comparing *Numbered Heads Together* and WCQA, the average effect size favoring *Numbered Heads Together* was .89.[34] An effect size of .89 means a student scoring 50 using WCQA would score 81 had they been taught with *Numbered Heads Together!*

Rather than blaming cell phones and texting for lack of student engagement, instructors using traditional lectures and WCQA would do well to take a hard look at the instructional strategies they are using. There are alternative proven, engaging instructional strategies that prevent texting and mind-wandering, and which enhance joy and success in teaching and learning.

References

[1] Lieberman, M.D. **Social. Why our brains are wired to connect**. New York, NY: Crown Publishing Group, 2013.

[2] Lieberman, M.D. Social. **Why our brains are wired to connect**. New York, NY: Crown Publishing Group, 2013, 117-118.

[3] Harrision, B.J., Pujol, J., Lopez-Sola, M., Hernandez-Ribas, R., Deus, J., Ortiz, H., Soriano-Mas, C., Yücel, M., Pantelis, C., & Cardoner, N. Consistency and functional specialization in the default mode brain network. **Proceedings of the National Academy of Sciences**, 2008, 105(28), 9781-9786.

[4] Spreng, R.N., Mar, R.A., & Kim, A.S. The common neural basis of autobiographical memory, prospection, navigation, theory of mind, and the default mode: A quantitative meta-analysis. **Journal of Cognitive Neuroscience**, 2009, 21(3), 489-510.

[5] Lieberman, M.D. **Social. Why our brains are wired to connect**. New York, NY: Crown Publishing Group, 2013, 22.

[6] Heider, F., & Simmel, M. An experimental study of apparent behavior. **American Journal of Psychology**, 1944, 57(2), 243-259.

[7] Klin, A. Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: The Social attribution task. **Journal of Child Psychology and Psychiatry**, 2003, 41(7), 831-846.

[8] Van Overwalle, F. A dissociation between social mentalizing and general reasoning. **NeuroImage**, 2011, 54(2), 1589-1599.

[9] Mason, M.F., Norton, M.I., Van Horn, J.D., Wegner, D.M., Grafton, S.T., & Macrae, C.N. Wandering minds: The default network and stimulus-independent thought. **Science**, 2007, 315(5810), 393-395.

[10] Lindquist, S.I., & McLean, J.P. Daydreaming and its correlates in an educational environment. **Learning and Individual Differences**, 2011, 21(2), 158-167.

[11] McKiernan, K.A., D'Angelo, B.R., Kaufman, J.N., & Binder, J.R. Interrupting the "stream of consciousness": An fMRI investigation. **NeuroImage**, 2006, 29(4), 1185-1191.

[12] Bunce, D.M., Flens, E.A., & Neiles, K.Y. How long can students pay attention in class? A study of student attention decline using clickers. **Journal of Chemical Education**, 2011, 87(12), 1438-1443.

[13] Schooler, J.W. Re-representing consciousness: Dissociations between experience and meta-consciousness. **Trends in Cognitive Science**, 2002, 6(8), 339-344.

[14] Lindquist, S.I., & McLean, J.P. Daydreaming and its correlates in an educational environment. **Learning and Individual Differences**, 2011, 21(2), 158-167.

[15] Smallwood, J., & Schooler, J.W. The restless mind. **Psychological Bulletin**, 2006, 132(6), 946-958.

[16] Smallwood, J., Fishman, D.J., & Schooler, J.W. Counting the cost of an absent mind: Mind wandering as an underrecognized influence on educational performance. **Psychonomic Bulletin & Review**, 2007, 14(2), 230-236.

[17] Killingsworth, M.A., & Gilbert, D.T. A wandering mind is an unhappy mind. **Science**, 2010, 330(6006), 932.

[18] Cameron, P., & Giuntoli, D. Consciousness sampling in the college classroom or is anybody listening? **Intellect**, 1972, 101(2343), 63-64.

[19] Shaw, G.A., & Giambra, L. M. Task-unrelated thoughts of college students diagnosed as hyperactive in childhood. **Developmental Neuropsychology**, 1993, 9, 17-30.

[20] Smallwood, J., & Schooler, J.W. The restless mind. **Psychological Bulletin**, 2006, 132(6), 946-958, 956.

[21] Bunce, D.M., Flens, E.A., & Neiles, K.Y. How long can students pay attention in class? A study of student attention decline using clickers. **Journal of Chemical Education**, 2011, 87(12), 1438-1433, 1442.

[22] Wilson, K., & Korn, J.H. Attention during lectures: Beyond ten minutes. **Teach Psychology**, 2007, 34(2), 85-89.

[23] Lindquist, S.I., & McLean, J.P. Daydreaming and its correlates in an educational environment. **Learning and Individual Differences**, 2011, 21(2), 158-167.

[24] Smallwood, J., Fishman, D.J., & Schooler, J.W. Counting the cost of an absent mind: Mind wandering as an underrecognized influence on educational performance. **Psychonomic Bulletin & Review**, 2007, 14(2), 230-236.

[25] Schooler, J.W., Reichle, E.D., & Halpern, D.V. Zoning out while reading: Evidence for dissociations between experience and metaconsciousness. In D.T. Levin (ed.), **Thinking and Seeing: Visual Metacognition in Adults and Children**. Cambridge, MA: MIT Press, 2004. 204-226.

[26] Schooler, J.W., Reichle, E.D., & Halpern, D.V. Zoning out while reading: Evidence for dissociations between experience and metaconsciousness. In D.T. Levin (ed.), **Thinking and Seeing: Visual Metacognition in Adults and Children**. Cambridge, MA: The MIT Press, 2004, 204-226.

[27] Smallwood, J., McSpadden, M., & Schooler, J.W. The lights are on but no one's home: Meta-awareness and the decoupling of attention when the mind wanders. **Psychonomic Bulletin & Review**, 2007, 14(3), 527-533.

[28] Lindquist, S.I., & McLean, J.P. Daydreaming and its correlates in an educational environment. **Learning and Individual Differences**, 2011, 21(2), 158-167.

[29] Smallwood, J., Beech, E.M., Schooler, J.W., & Handy, T.C. Going AWOL in the brain – mind-wandering reduces cortical analysis of the task environment. J**ournal of Cognitive Neuroscience**, 2008, 20(3), 458-469.

[30] Risko, E.F., Anderson, N., Sarwal, A., Engelhardt, M., & Kingstone, A. Every attention: Variation in mind-wandering and memory in a lecture. **Applied Cognitive Psychology**, 2012, 26(2), 234-242.

[31] Kagan, S., & Kagan, M. **Kagan Cooperative Learning**. San Clemente, CA: Kagan Publishing, 2009.

[32] Kagan, S. **Brain-Friendly Teaching. Tools, Tips, and Structures**. San Clemente, CA: Kagan Publishing, 2014, in press.

[33] Kagan Publishing, San Clemente CA: http://www.kaganonline.com.

[34] Studies described in: Kagan, S. **Kagan Cooperative Learning Structures**. San Clemente, CA: Kagan Publishing, 2013.

Chapter 11

IAE Newsletter - Issue 141, July, 2014

The Administrative Role in Interactive Instruction

Doug Gleave
Retired Superintendent of Schools
Saskatoon, Saskatchewan

The three previous chapters focused on an educational issue that has emerged out of the recent global interest in hand-held wireless social media devices. We're a social species, and these devices enhanced social interactions in unprecedented ways. The first chapter underlined the central role that attention plays in cognition. Engagement of emotion and attention activates memory, problem solving, and learning. Smart phones and hand-held computers certainly enhance social interaction, but they are also potentially distractive. The second chapter suggested how to help students with attention disorders effectively manage technological distractions.

The third chapter suggested that when teachers focus on non-social instruction, students will move towards social interactions. Cell phones now provide a much better socially interactive venue for that than surreptitiously passing notes. This suggests that teachers should move towards student-driven highly interactive instruction.

The Role of Administration

This chapter expands that issue: What can school and district administrators do to enhance a socially-oriented instructional shift? Most stakeholder groups want schools to adapt to new cultural changes, but curricula, instruction, and technology have changed only modestly from when I was a superintendent of schools in Saskatoon, Saskatchewan, fifteen years ago. The changes that occur are promising, however.

Instruction is gradually and appropriately changing from transmission and rote acquisition to interactive approaches such as critical and creative inquiry, cooperative learning, and flexible use of instructional time. Still, tablets and laptop computers are used mainly for homework at many schools. School computer labs are often still scheduled for subject-based project work once every week or so.

Teachers are often blamed for a failure to keep up with research findings in highly interactive instructional areas. The teacher is, after all, responsible and accountable for classroom instruction (Gleave, 1997). However, instruction is only one of five components for school culture and student learning. The other four relate to school vision, curriculum, evaluation systems, and organizational structure. These are greatly influenced by building and district administrators, who can promote or hinder instructional change. For example, organizational structures such as school facilities, homogeneous grouping for instruction, and rigid time periods are basically unchanged from the 1950s when I attended school.

My twenty years of experience as Saskatoon superintendent of staff development and then as superintendent of schools convinced me that the individual school was, and is, the most effective unit for implementation of changes in curriculum and instruction. In this approach, the school superintendent effectively contributes to school change by facilitating and supporting individual school level innovation. Teachers participate through professional learning, teamwork, and collegial coaching. The building principal needs to help shape school culture through collegial and purposeful leadership.

School culture is used here to refer to the "taken for granted" way that we do things at a particular school. Culture is the most effective way for school administrators to understand and influence curriculum and instruction in their school. The components of school culture are the same as for a school district. Their actual implementation varies from school to school, and this variation constitutes a challenge to the superintendent.

The five components of school culture combine to guide the way that the principal, teachers, and students do things in this school. When these components are planned and act in concert, a school's instruction can be updated quickly and effectively to provide the interactive instruction that Kagan (2014) advocates in the previous chapter. If the components are not acting in concert with proposed changes in instruction, one or more of the other four systems will impede the desired changes to instruction. As Mitra suggested in aa 2014 *IAE Newsletter* (Moursund, March, 2014), our schools are not broken. They are simply out of date in some or all of the above components.

A Planning Workshop for an Individual School

A three-day planning workshop (Weisbord, 1987) provides an excellent resource for school administrators who want to implement the highly interactive approach to instruction advocated by Kagan (2014). The planning workshop can simultaneously (1) incorporate complementary ways for schools to address cell phones and attention, and (2) consider all five components of school culture to ensure they act in concert.

A workshop facilitator will initially involve all teachers and administrators in a conversation that identifies past school successes and documents current difficulties and problems. Teachers and administrators can then jointly create a desired future that includes interactive instruction, improved attention, and effective use of technology.

On the final day of the initial workshop the group should develop concrete action plans for both the school and individual classrooms to implement the desired approach to school purposes, curriculum, instruction, evaluation, and organizational structure/technology. The plan should then be implemented using teamwork, problem solving, and coaching. Additional workshops provide time and opportunity for follow-up planning and encouragement.

Technology in School Culture

Workshop consideration of technology in school culture should include investigating the potential for positive, benign, and harmful effects of cell phones, tablet computers, and desktop computers. Creative and planned use of these devices can become an integral and valuable asset to highly interactive instruction (Moursund, February, 2014, and May, 2014). When ignored, these devices provide an easy distraction from learning.

Similarly, these devices can be used for antisocial, harassing, and bullying behavior. Zero tolerance policies toward harassment and bullying are a necessary but an insufficient response from schools. Changing a school's culture is the most effective way to prevent unproductive and antisocial use of technology.

Early in my career as a physics teacher, most students readily understood the physics concepts, principles, and equations. However, many students had trouble with the complex calculations required in physics. The slide rule was a technology I taught to help students calculate quickly and accurately. Later, hand-held calculators became a simpler and faster way to calculate. Many physics teachers resisted these innovations and refused to allow students to use slide rules and calculators in year-end exams.

This provides a good example of where school-wide (indeed, district-wide) planning and cooperation would have been helpful. From my point of view as a physics teacher, I believed that students needed to learn to make effective use of calculators in their math classes, and then make use of them in their science, business, and other classes where such tools are important to practitioners.

Some of the same calculator-acceptance ideas apply to cell phones and tablet computers. Students readily learn the rudiments of cell phone and tablet computer use without the help of our school system. But, what deeper learning and use do we want students to learn to apply in a manner that cuts across the various courses they take?

Information retrieval from the Web and by communication with individuals or groups of people provides an excellent example. Yet many teachers are still reluctant to embrace computers and cell phones as an aid to student learning.

Decision Makers and Stakeholders

As a superintendent of schools I would meet with the school principal after the three-day workshop to review administrative tasks:

- The principal's plan to meet with parents regarding workshop proposals for school vision, curriculum, instruction, evaluation and organizational structure. This would provide an opportunity for parental clarifications and concerns.
- The principal's budget estimates to enable implementation of workshop plans would be considered. Existing school and district budgets would be considered before any budget proposals to increase funding from the Board of Education.
- The principal's conversations with any teacher actively opposed to changing the five components of school culture. The principal would be advised to encourage the teacher to collaborate with other teachers in implementing and modifying the plan. The teacher would also be advised that individual teachers do not hold a veto on the plan. If their opposition is firm and unyielding the teacher would be gently reminded of their opportunity to request a transfer to another school in the next school year. The intent of this option is to avoid unhappiness and unresolved conflict.

It is crucial that administrative tasks reflect the interactive spirit of the school culture created in the workshop. The principal's response to parental and teacher concerns must be collaborative and problem solving. The shared interests of all parents, teachers and administrators must be understood and pursued in an ongoing manner.

As mentioned earlier, I am convinced that implementation of interactive education and technology is most effective when each school creates its own school culture within the context of district goals and priorities. In this model, an exemplar school provides enthusiasm and a model for other schools to adapt to their situation.

School culture is 'the taken for granted way we do things around here'. Culture is socially constructed through extensive dialogue, peer coaching, joint problem solving and planning workshops. This conversation is especially powerful when it includes school vision, curriculum, instruction, evaluation and organizational structure. Gleave (1994) documented how changing school culture assisted some Saskatoon schools in shifting from transmission oriented instruction to interactive instruction. School culture will also work for using cell phones and tablets positively and productively.

Summary

School culture is taken for granted as "the way we do things around here." Culture is socially constructed through extensive dialogue, peer coaching, joint problem solving, and planning workshops. This conversation is especially powerful when it includes school vision, curriculum, instruction, evaluation and organizational structure. Gleave (1994) documented how changing school culture assisted some Saskatoon schools in shifting from transmission oriented instruction to interactive instruction. The same approach will also work for using cell phones and tablets positively and productively.

References

Gleave, D. (1997). Bifocals for teacher development and appraisal. *Journal of Curriculum and Supervision*, 12(3), 269-281.

Gleave, D. (1994). Changing school culture through transactional education. *Journal of Staff Development*, 15(2), 8-11.

Kagan, S. (June, 2014). Education for students' futures. Part 9: The problem is not the cell phone. *IAE Newsletter*. Retrieved 3/27/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-140.html.

Moursund, D. (May, 2014). Education for students' futures. Part 6: The second machine age. *IAE Newsletter.* Retrieved 3/27/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-134.html.

Moursund, D. (March, 2014). Education for students' futures. Part 3: Sugata Mitra's thoughts on the future of learning. *IAE Newsletter.* Retrieved 3/27/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-137.html.

Moursund, D. (February, 2014). Education for students' futures. Part 1: Introduction. *IAE Newsletter.* Retrieved 3/27/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-132.html.

Weisbord, M. (1987). *Productive workplaces: Organizing and managing for dignity, meaning and community*. San Francisco, Jossey-Bass.

Part 3: Human Brain and Computer Brain

As the field of artificial intelligence developed into an important component of Computer and Information Science, researchers began to explore the capabilities and limitations of human and computer brains.

From the beginning, it was evident that computers were better than humans at arithmetic and a number of other data processing tasks. Over the years, computer technology has made very rapid progress and the field of artificial intelligence has made considerable progress. There are a steadily increasing number of tasks in which computer "brains" are better than human brains.

This presents a major challenge to our current schooling system. If a computer can solve or make a major contribution in solving a type of problem that students have formerly learned to solve using "by hand" methods, what should we now be teaching students about this type of problem?

This question also applies to jobs—such as teaching—that make extensive use of intelligence. Teaching Machines are getting better and better!

Chapter 12

IAE Newsletter - Issue 142, July, 2014

Conscious and Unconscious Response–A Cognitive Neuroscientist's Perspective

Robert Sylwester
Emeritus Professor of Education
University of Oregon

The *IAE Newsletter* has regularly reported on the scientific developments in consciousness. It recently compiled its published articles into a free downloadable book, *Consciousness and Morality: Recent Research Developments* (Sylwester & Moursund, 2013). Research activity continues unabated on what may be the most significant mystery remaining in the neurosciences, a mystery that's perhaps finally approaching a basic solution. This and the next chapters are from the perspectives of a renowned cognitive neuroscientist and a renowned theoretical physicist.

Before you go any further, watch this fascinating three-minute video of a bird that must follow eight separate steps in order to solve the problem of getting a stick that's sufficiently long enough to retrieve some food. Then ask yourself if the bird's behavior approaches the level of a rationally conscious response. See https://www.youtube.com/watch?v=AVaITA7eBZE.

Consciousness

What's the point of consciousness? The brain-wide information sharing system that now seems to define consciousness allows relevant cortical and subcortical systems to interact before agreeing to one interpretation of an event. This shared decisional system within a single brain could also help us to understand how groups of brains might also democratically solve complex cultural issues. It also makes it possible to finally consider the possibility of machine consciousness a couple of thousand years after Socrates suggested how important it was to "know thyself."

In his recent highly acclaimed book, *Consciousness and the Brain: Deciphering How the Brain Codes Our Thoughts* (2014), the world-renowned neuroscientist Stanislas Dehaene analyzed and reported on the consciousness research that his and other laboratories carried out. Dehaene believes that advanced research technologies during the past 20 years now allow neuroscientists to finally free themselves from the concept of a disembodied consciousness and to strongly support the existence of brain correlates, which are probably centered in our brain's dorsolateral prefrontal cortex, but are then connected with most other brain systems (Dehaene, p. 101).

To paraphrase Dehaene: The previous black box of consciousness is now open. Thanks to a variety of experimental paradigms, scientists have learned how to make pictures visible or invisible, and then to track the patterns of neuronal activity that occur only when conscious access exists. Understanding how our brain handles seen and unseen images has turned out to be not as difficult as initially feared. Many electrophysiological signatures have manifested the presence of a conscious ignition. These signatures of consciousness have proved solid enough that they are now being used in clinics to probe consciousness in patients who have massive brain lesions. What's wonderful is the realization of how far the search for discovery has now gone.

Three significant factors that drive this new development are: (1) the emergence of a better definition of consciousness, (2) the realization that consciousness can now be credibly studied, and (3) an increased understanding of and respect for the nature of subjective phenomena.

The quantity and quality of the research Dehaene describes is very impressive, a major step forward. His book requires a basic understanding of brain systems and research procedures, but at that level it is clearly and impressively written.

The Unconscious Mind

We're only conscious of our conscious thoughts. Outside of research labs we're unaware of our unconscious operations, so we tend to overestimate the role that consciousness plays in our physical and mental lives. Dehaene believes that the research credibly indicates that our brain contains unconscious systems that constantly monitor our environment and assign values that guide our attention and thus shape much of our behavior. The initially meaningless incoming stimuli become a set of opportunities that in parallel are carefully and unconsciously sorted according to their relevance to current goals. Only the most relevant stimuli draw enough attention to enter into consciousness. Below that level unconscious systems ceaselessly and statistically evaluate probabilities. Much of our attention thus operates largely in a subliminal manner. Think of TV weather forecasters who combine a myriad of unconscious statistical observations before they consciously and briefly predict weather probabilities during the next few days.

In another recent acclaimed book, *Thinking, Fast and Slow*, Daniel Kahneman also makes the similar significant point that much human decision making is automatic, reflexive (Kahneman, 2013).

The Conscious Mind

We're not zombies that only function unconsciously. Consciousness is an evolved property that emerged because it usefully fulfills specialized processes that an unconscious mind can't perform alone.

Since most inputs into our brain are initially suppressed, consciousness includes the need to be awake, vigilant, and to have a specific attentive focus (all of which Dehaene suggests have both unconscious and conscious elements). Since we can simultaneously consciously deal with only a few inputs at most, the determination of the significant and insignificant is important.

The concept of conscious access is the central element in our understanding of consciousness in that at least some of the information that we specifically attend to must eventually reach cognitive levels that allow us to report our thoughts to others. Being awake and attentive aren't enough. Conscious access implies a sense of self, the "I" who is interpreting and commenting on the results of conscious experience.

Research laboratories can now use advanced imaging technologies that will activate only if the subject is having a conscious experience. For example, specific remarkably stable bursts of high level neuronal activity (that Dehaene calls signatures of consciousness) change massively and predictably regardless of the sensory input that activated the conscious experience.

Dehaene and his collaborators further theorize the concept of a global neuronal workspace that begins in the frontal lobes but is widely distributed throughout our brain. It identifies potentially relevant information from the vast number of sensory inputs from within and without our body. Consciousness is the evolved system that allows us to keep information in mind within our brain's global workspace (but detached from the external world) while we decide how best to respond to it. It's closely related to what other cognitive neuroscientists call our working brain.

Dehaene relates this reductive element of consciousness to the spokesperson of a large organization who reduces the complexity of an issue to a simple non-technical announcement that expresses its substance. The global workspace thus maintains conscious thought that it can incorporate into understanding past and current events and making future plans. The philosopher Daniel Dennett wryly calls such increased activity in the global workspace as "fame in the brain."

Beginnings and Endings

Various maternal hormones sedate a preconscious fetus. Birth triggers a massive surge of stress hormones and neuronal stimulations that activate the various systems that regulate consciousness. Conscious behavior begins slowly and sluggishly, developing over a 20-year period, as parents and educators well know. Delivery is thus the genuine birth of a conscious mind.

Illness and accidents can result in conditions that adversely affect conscious capabilities. Schizophrenia, dementia, coma, and vegetative states are examples. Dehaene is optimistic that the direction of current research and clinical intervention will help many whose conscious capabilities are now limited.

Animals and Machines

Mammals and many species of birds seem to have the neurobiology necessary for a global workspace and thus for reflexive and conscious response. Many also have metacognitive capabilities (the ability to know the limits of one's knowledge). The difference between human and animal consciousness probably exists within our capabilities with articulate language and theory of mind (to be able to represent and reason about what others think). On the other hand, the ability of such tiny social animals as ants and bees to function effectively within their societies and environments suggests that the concept of consciousness itself might need to be reconsidered.

That issue might also refer to the concept of machine consciousness. Dehaene (2014) suggests that in principle, he sees no reason why machines couldn't have some form of consciousness.

As a social species, we have a tribal tendency to adopt the conscious beliefs of others. We thus tend to develop cultural beliefs either by conscious choice or by default (such as accepting parental beliefs) and so we often allow such organizations as religions and political parties to influence our thinking through their biased basic perspectives. In effect, they do our preliminary thinking. Is this any different than accepting the opinions of newspaper columnists or TV pundits? How socially driven human beliefs relate to machine consciousness provides an intriguing problem, one that the next two articles will explore.

Our understanding of the field of consciousness is thus growing rapidly, but so are the questions about it. See, for example, the work of David Chalmers (3/19/2014). Quoting from this reference:

> For much of 20th century, Chalmers says, an idea that there could be no scientific study of consciousness held sway: Psychologists studied objective facts about behavior, neuroscientists studied the material of the brain. About 20 years ago that started to change. Prominent scientists like Francis Crick and Roger Penrose started saying: Now is the time to attack this problem. "This has been wonderful, and great, but also has limitations." Principally, the work so far has been a search for correlations between areas in the brain and conscious states. As he says, "This is still a science of correlations, not explanations."

References

Chalmers, D. (3/19/2014). The hard problem of consciousness. David Chalmers at TED2014. *TED Talks*. (18:37 video.) Retrieved 7/19/2014 from http://blog.ted.com/2014/03/19/the-hard-problem-of-consciousness-david-chalmers-at-ted2014/.

Dehaene, S. (2014). *Consciousness and the brain: Deciphering how the brain codes our thoughts*. New York: Penguin. See a review of the book at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3971003/.

Kahneman, D. (2013). *Thinking, fast and slow*. New York: Farrar, Straus, Giroux. A synthesis of the book is available at http://i-a-e.org/newsletters/IAE-Newsletter-2012-89.html.

Sylwester, R., & Moursund, D., eds. (2013). *Consciousness and morality: Recent research developments*. Eugene OR: Information Age Education. Available for free download: Microsoft Word file from http://i-a-e.org/downloads/doc_download/252-consciousness-and-morality-recent-research-developments.html. PDF file from http://i-a-e.org/downloads/doc_download/251-consciousness-and-morality-recent-research-developments.html.

Chapter 13

IAE Newsletter - Issue 143, August, 2014

The Future of the Mind–A Theoretical Physicist's Perspective

Robert Sylwester
Emeritus Professor of Education
University of Oregon

The previous chapter explored recent advances in our understanding of consciousness from the perspective of a cognitive neuroscientist, Stanislas Dehaene. This chapter focuses on the perspective of a theoretical physicist, Michio Kaku, as explored in his excellent non-technical book, *The Future of the Mind: The Scientific Quest to Understand, Enhance, and Empower the Mind* (2014). Kaku takes readers on an incredible tour from the beginnings of consciousness and intelligence to the increased roles that robotic technology will play in future cognitive behavior—and then finally on to possible explorations in other planets.

Telescopes that could compress space and allow us to see galaxies up close were invented 350 years before we could make the major step forward to enter the space age. Conversely, it only took 15 years from the invention of brain imaging technology to allow us to observe brain functions up close.

We now know quite a bit about the natural forces of gravity, electromagnetism, and weak/strong nuclear forces. Part of the rapid progress in the ability to observe brain function occurred because physicists now have a good understanding of electromagnetism. These govern the electrical signals that process neuronal activity and are also the basis of the most advanced imaging technologies. Cognitive neuroscientists, who understood about 30 brain regions prior to imaging technology, now understand the basic roles of several hundred regions.

A Conscious Brain

Consciousness is central to human rational thought. Animal consciousness is predicated on the kinds of information that are important to the survival of the species (which differs in bats, dolphins, and humans, for example).

Kaku has developed a space and time theory of consciousness that he defines as follows:

> Consciousness is the process of creating a model of the world using multiple feedback loops in various parameters (e.g., in temperature, space, time, and in relation to others), in order to accomplish a goal (e.g., find mates, food, shelter). (Kaku, 2014.)

This definition can be applied to all forms of life. So, Kaku uses it to discuss the consciousness levels of bacteria, plants, various animals including chimpanzees and elephants, and human beings. Among these living entities, humans are best at creating mental models of possible futures and working to achieve a future that the human believes is desirable.

Kaku presents an interesting comparison between a room thermostat that can sense temperature and make a decision to turn a heater or air conditioner on or off, versus a flower that can sense temperature, moisture, sunlight, gravity, and so on, and act on this information. In Kaku's definition, a flower has a higher level of consciousness than the thermostat, and humans currently are at the high end of his scale. This type of example lays groundwork for discussions of whether an artificially intelligent computer can have consciousness (yes, according to Kaku's definition) and whether this level of consciousness might someday equal or exceed that of humans.

In humans, our brain sub-units use the brain's feedback loops to create a model that best represents and responds to the current challenge. The feedback loops process how we relate to space, time, society, and a possible future. The internal, almost collegial brainstorming that we engage in (often at multiple levels) seems so normal that we're not really aware of it. Eventually our brain's CEO (the dorsolateral prefrontal cortex) receives input from various brain sub-units, and makes up its mind after evaluating the past, assessing the present, and simulating the future. If we make a wrong decision we'll typically come up with an explanation that makes the decision appropriate. Or else we'll just laugh it off.

The laughter of humor depends on the punch line. We can imagine how the story will turn out on the basis of our extensive understanding of the physical and social world. Laughter is the release when the punch line provides an unexpected conclusion. That's the essence of humor. Our survival depends on our ability to foresee and effectively respond to unanticipated events. Humor certainly has other values but a sense of humor develops and maintains this capability in a pleasant non-threatening way. Play, games, and gossip are similar to humor in that they deal with unexpected outcomes to the solutions that folks develop.

Beyond Our Current Brain

The size of the female birth canal led to a human brain that is just 1/3 of its adult size, leading to an extended juvenile dependent period that is focused on nurturing and formal education. We've become a very successful social species with a current life span in the upper 70s. The chimpanzee is our closest genetic relative, sharing 98.5% of our genes. It has half our life span and lacks both articulate speech and human technological capabilities. We thus have a slight genetic and social edge that scientists are now trying to understand.

What do we humans need to know about our cognitive capabilities and limitations in order to live in a probably increasingly complex world, given the profound ecological challenges that confront humans and the rest of the biosphere and the effect of advances in science and technology? Kaku devotes much of the rest of his book to this issue. His basic point is that we've pretty much maxed out the cognitive capabilities that we've developed through evolutionary processes. It may, however, be possible to use a combination of gene therapy, drugs, and imaging capabilities to increase our intelligence and collaborative potential in order to enhance our chances for survival and the survival of the rest of the biosphere.

A relatively inexpensive approach would be to encourage the development of delayed gratification in children. The evidence is strong from longitudinal studies that children who are willing to delay gratification mature into adults who are socially and vocationally successful. In our governmental and public activities, we can compare the costs of regular maintenance and replacement against the ultimate cost of deferring maintenance and replacement. It's much cheaper to provide regular maintenance of such things as a public building or a bridge, or to respond in a timely manner to massive issues such as global warming. However, we seem to prefer to not tax ourselves a little now, opting instead for our children to tax themselves substantially.

It's not that we don't intellectually understand the cost of delay. We have a rich history of the cost of cultural and economic neglect. Knowing what has happened in the past is basically the initial element in solving problems in the present with an eye to the future. For example, Kaku provides incredible descriptions of new technological discoveries that will enhance intelligence and motor control for people who suffer from various sensorimotor disabilities. Will we encourage the development and adoption of such technologies or continue to warehouse the disabled?

Altered Forms of Consciousness

Various maternal hormones sedate a preconscious fetus. Birth triggers a massive surge of stress hormones and neuronal stimulations that activate the various systems that regulate consciousness. Conscious behavior begins slowly and sluggishly, developing over a 20-year period, as parents and educators well know. Delivery is thus the genuine birth of a conscious mind.

Illness and accidents can result in conditions that adversely affect conscious capabilities. Schizophrenia, dementia, coma, and vegetative states are examples. Dehaene is optimistic that the direction of current research and clinical intervention will help many whose conscious capabilities are now limited.

A Robotic Future

Life forms emerged on earth 3.5 billion years ago when the ocean's stirred organic soup produced the self-perpetuating bubbles of organic matter that became our planet's earliest life forms. Error-prone copying resulted in a continuous production of diverse forms of life. Those that best adapted to the current conditions flourished, while the incidence of less-adapted forms decreased. Sentient conscious people appeared 200,000 years ago. Kaku suggests that we're probably still several decades away from developing robots that can function normally in human society. Even then such issues as self-awareness, recognizing emotions, feeling pain, and developing ethical behavior indicate the great distance between what robots can do now and will still need to master. Analogically-driven science fiction books and films are leading the way (Sylwester, 2013).

Could the basic concept of evolutionary progression continue into the future as human wetware and robotic hardware merge, something analogous to the symbiotic relationship that we already have with bacteria and immune cells? Many of us now wear glasses and some have pacemakers, cochlear implants, or artificial retinas. Most people carry a cell phone. Will the emerging wetware/hardware combination stop at this, or will we reach a point at which replicating inorganic material can exist within humans as bacteria and immune cells currently do? Given the concept of evolution, does a scientific reason exist why it can't?

Cognitive neuroscientist Douglas Hoffstadter suggested to Kaku in a discussion that we might begin to think of robots as being our children. We should begin to love them as we do our human children, realizing that robots might take over in the end (as our human children do now).

Childhood includes playing games as an informal introduction into adult life, but during recent decades video games began to supplant balls and dolls. The primitive Pac-Man morphed into complicated socially-oriented video games that explore elements of 21st century life. Both computer games designed mainly for entertainment and "serious" computer games designed for both education and entertainment are important aspects of today's informal and formal education.

References

Kaku, M. (2014). *The future of the mind: The scientific quest to understand, enhance, and empower the mind.* New York: Doubleday.

Kaku, M. (n.d.). Dr. Kaku's must-see videos. Retrieved 7/19/2014 from https://www.youtube.com/playlist?list=PL101E166E120852F9.

Sylwester, R. (2013). The central roles of the variety of analogy. *IAE Newsletter.* Retrieved 7/19/2014 from http://i-a-e.org/newsletters/IAE-Newsletter-2013-121.html.

Chapter 14

IAE Newsletter - Issue 145, September, 2014

Introduction to the Future of Teaching Machines

David Moursund
Emeritus Professor of Education
University of Oregon

> "There must be an 'industrial revolution' in education, in which educational science and the ingenuity of educational technology combine to modernize the grossly inefficient and clumsy procedures of conventional education." Quoted from the 1933 book, *Psychology and the New Education* (Sidney Pressey; American psychologist; 1888-1979).

> "Historically, the elementary school has been totally labor-intensive. Tomorrow's elementary school will be heavily capital-intensive." (Peter Drucker; Austrian writer and management consultant, and self-described social ecologist; 1909-2005.)

This chapter explores ways that teaching machines will change the role of teachers by enabling schools to provide increased student individualization. They will change the content that is taught, because computers are such a powerful aid to problem solving. They will serve as a vehicle to help implement research results that are being shown to improve education. This chapter is a slightly modified version of an earlier *IAE Newsletter* (Moursund, September, 2014a).

Written materials—along with knowledge and skills in reading and writing—were the first general purpose teaching machines. What a great technological breakthrough! Teach students the rudiments of reading and writing, and then provide them with books and writing implements. The book, as a teaching machine, could help students to gain a steadily increasing level of literacy and could also help them to gain knowledge and skills in any area that could be represented in written form. Moreover, writing is a powerful aid to the human brain in both communication and problem solving.

The rapid growth of Information and Communications Technology (ICT) over the past 60 years has made possible the development of teaching machines that include all of the capabilities of book-based reading-assisted instruction and writing-assisted problem solving and communication—and also to greatly extend these capabilities.

Isaac Asimov's Vision of a Teaching Machine

Science fiction writers have long considered the possibility of teaching machines that were better than books. Isaac Asimov, one of the leading science fiction writers of the 20th century, addressed this topic in his essay, The New Teachers, in which each student has access to a teaching machine that includes access to a global library. Quoting from the 1976 essay:

> We can reasonably hope that the teaching machine will be sufficiently intricate and flexible to be capable of modifying its own program (that is, "learning") as a result of the student's input.
>
> In other words, the student will ask questions, answer questions, make statements, offer opinions, and from all of this, the machine will be able to gauge the student well enough to adjust the speed and intensity of its course of instruction and, what's more, shift it in the direction of the student interest displayed.
>
> …
>
> All teaching machines would be plugged into [a] planetary library and each could then have at its disposal any book, periodical, document, recording, or videocassette encoded there (Asimov, 1976).

Our technological progress during the years since 1976 now allows us to build teaching machines that surpass Asimov's fictional futuristic teaching machine.

Historical Background

Beginning in the late 1950s, the United States and Canada built an "early warning" system of radar and computers that could detect and report on missiles being launched over the North Pole toward their countries. Operators viewed a computerized TV display screen and could act on the data they were receiving. The same display screen could show simulated (previously recorded or computer-generated) data. So, system operators could be trained/educated using quite authentic simulations. This integration of a problem-solving tool with a teaching tool was a huge breakthrough in teaching machines.

In 1960, the first PLATO (Programmed Logic for Automatic Teaching Operations) system became operational on a computer at the University of Illinois. Like any well-conceived teaching machine project, PLATO's capabilities grew over time as better hardware became available, as data was gathered from users, as research progress occurred in theories of teaching and learning, and as the content developers and programmers became more adept at their tasks.

One of great powers of teaching machines is that they can gather data as they interact with students. As Asimov forecast, this data can be used to individualize instruction. In addition, it can be used in research into the areas of teaching and learning.

The results of this research can be incorporated into the software of teaching machines. Compare this easy upgrade of the machine's capabilities to the task of "upgrading" hundreds of thousands of human teachers. This ease of upgrading teaching machines is one reason they will gradually play a larger and larger role in lifelong informal and formal education.

My "Near Future" Teaching Machine

Of course, my teaching machine will be small and portable. It will have a high-resolution color display touch screen, long battery life, fast connectivity to the Internet, voice input, voice output, and automatic translation among languages from both text and voice. Using its built-in intelligence, compute power, and connectivity, it will be able to solve or help greatly in solving a huge range of problems of the types that people encounter in school, in their everyday lives, and on the job. This teaching machine will be aware of its user's location, will act as a GPS, and will access and process the visual and sound information that its user is receiving from both the physical and electronic environments. It will always be available, and it will facilitate "just in time" learning.

Here are some details elaborating the previous paragraph.

1. You are probably familiar with a computer named Deep Blue that defeated the reining world chess champion Garry Kasparov in 1997, and a computer named Watson that defeated two of the best human players of the TV game Jeopardy in 2011. IBM's work with its computer system captures the flavor of progress in using powerful computers to help solve a wide range of human problems in healthcare, research, and a number of other areas.

   My "near future" teaching machine not only provides students with ready access to such systems but also integrates use of these systems into the everyday curriculum. See my *IAE-pedia* article, Two Brains Are Better than One (Moursund, 2015).

2. Here is a recent personal story. I had a question about some details of Piaget's four-stages of human cognitive development, and I was unable to find an answer via an hour of Web searches. So I sent my question to a Piaget distribution list. A couple of the responses cited references in Spanish and French. Another then noted that he was unable to find an English translation of the French citation that he felt contains an answer. That led to a response from another person who said roughly, "That's not a problem. Simply copy the French text into the free Google Translate system on the Web."

   We already have relatively good voice input systems that translate speech into text. We have good voice output systems that translate text into speech. The combination of these capabilities with language translation capabilities means that students throughout the world will be able to easily communicate orally and by text with each other.

3. We know a considerable amount about individual differences among learners, the value of individualization of instruction, the value of human tutors, and the value of computer tutors. My teaching machine will respectfully accommodate our understanding that there are many aspects of teaching and learning in which human teachers and student-human interactions are both absolutely necessary, and are much more effective, than our current computer teaching machines.

   However, it will also reflect that there are already many things that a teaching machine can do better than human teachers, and there are many things that a human teacher plus a teaching machine working together can do better than either working alone. A student's teaching machine will gradually learn which of these three approaches works best in a particular learning area for the student it is serving.

4. We know that there are considerable differences in beliefs and understandings among people of different nationalities, cultures, and religions. Many years ago, one of my students exposed me to the idea of the imperialism of one country inflicting its educational system and curriculum content on another country. This might be acceptable to both countries in the discipline of math, but quite unacceptable in global and national history, in politics, and in many other disciplines. For example, some of the curriculum content of the fine and performing arts that is broadly accepted in many areas of the world may not be at all acceptable in other areas. Add to this the need for students to learn to communicate in their native language and culture, and that inherent to a language is a great deal of culture and history.

   This means that the teaching machine needs to have a great deal of content and teaching methodology that is specific to the huge number of different sects living throughout the world and to the many different political systems. In education, one size does not fit all at the individual student level, the family level, and for larger groupings.

5. The first Massive Open Online Courses (MOOCs) were developed in 2011. By making use of data about the performance of all students enrolled in a MOOC, we are gradually improving the MOOCs. My forecast is that eventually such courses will have the characteristics of today's Highly-interactive Intelligent Computer-assisted Learning (HIICAL) courses. My teaching machine will provide students throughout the world with free access to a huge number of HIICAL courses will allow them to learn at a time and place of their choosing.

6. Some of our best success stories with teaching machines involve developing and using computer simulations. A good teaching/learning simulation engages a student in actually solving problems and accomplishing tasks. The simulated versions of the problems and tasks need to be close enough (authentic enough) to the "real thing" that there is very easy transfer from the learning to the use of the learning. We are making good progress toward creating Star Trek's Holodeck simulations, and less sophisticated simulations are now of routine use in education and research.

7. My teaching machine will be quite portable, thus largely obviating the need for students to have individual walking/talking robots. A future version of Google Glass will be one of the interfaces to teaching machines. Thus, for example, a student will be able to glance at a person and the computer system will display the person's name and identification information via the glasses. (If the person is someone I have met before, I want my teaching machine to retrieve information about previous meetings and conversations.) Similarly, students will be able to quickly retrieve information about almost anything (including people) they see, hear, or think about.

A number of additional items to this list are given in the next chapter.

Final Remarks

The design, production, and distribution of teaching machines needs to take into consideration both the educational needs of today's students and the changing educational needs of future students. We humans now have the knowledge, skills, and production capabilities to provide every person on earth with a quite good teaching machine. Once this approach to education is widely accepted, the capabilities of the teaching machines will increase rapidly as more and more materials are developed to facilitate this type of aid to teaching, learning, communication, and problem solving.

Human teachers and teaching machines working together can make education a lifelong endeavor and provide all people with an education that rivals the best education that currently is available to only a limited number of students.

We can overcome the technological and manufacturing challenges. But, can we overcome the acceptance, distribution, and other human challenges? I wish each of you a long life so that you can participate in and witness the outcomes of this endeavor.

References

Asimov, I. (1976). The new teachers. In *Robot visions*. London: Orion.

Kaku, M. (2014). *The future of the mind*. New York: Random House.

Moursund, D. (2015). Two brains are better than one. *IAE-pedia.* Retrieved 5/27/2015 from http://iae-pedia.org/Two_Brains_Are_Better_Than_One.

Chapter 15

IAE Newsletter - Issue 146, September, 2014

The Teaching Machine Is Both Tool and Teacher

David Moursund
Emeritus Professor of Education
University of Oregon

> "The medium is the message." (Herbert Marshall McLuhan; Canadian philosopher of communication theory and a public intellectual; 1911-1980.)
>
> "If you want to teach people a new way of thinking, don't bother trying to teach them. Instead give them a tool, the use of which will lead to new ways of thinking." (Richard Buckminster Fuller; American engineer, author, designer, inventor, and futurist; 1895-1983.)

Marshall McLuhan is well known for his statement that "The medium is the message." Like most people, I thought I understood what he meant by this statement. However, Mark Federman pointed out how wrong I was in his article, What is the Meaning of The Medium is the Message? (Federman, 7/23/2004). Quoting from his article:

> McLuhan tells us that a "message" is, "the change of scale or pace or pattern" that a new invention or innovation "introduces into human affairs." Note that it is not the content or use of the innovation, but the change in inter-personal dynamics that the innovation brings with it.… A McLuhan message always tells us to look beyond the obvious and seek the non-obvious changes or effects that are enabled, enhanced, accelerated or extended by the new thing.
>
> But McLuhan always thought of a medium in the sense of a growing medium, like the fertile potting soil into which a seed is planted, or the agar in a Petri dish. In other words, a medium—this extension of our body or senses or mind —is anything from which a change emerges.
>
> [Quoting McLuhan:] "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."

Computer as a Medium

You are probably familiar with the stories of Bill Gates and Paul Allen who dropped out of college and stated Microsoft, and Steve Jobs who dropped out of college to work with his friend Steve Wozniak to start Apple. The microcomputer was a new medium, and here is my view of the message:

> The new medium made it possible for relatively novice users of the medium to quickly become "world class" in some of their computer-related endeavors and help facilitate a huge change in the world.

Now, let me share three stories about examples of continuing changes being wrought by the computer-as-medium.

A Story about a 17-Year-Old

The December, 2013, issue of *Scientific American* includes a story about Eric Chen, who was a 17-year-old high school senior from San Diego, California, when he won the 2013 Google Science Fair (Kuchment, 10/21/2013).

Quoting Chen:

> I live in San Diego, where some of the first cases of 2009 H1N1 swine flu took place in the U.S. It was then that I made a realization that flue can kill a lot of people. I thought, "Why can't we use the new computer power at our fingertips to speed up drug discovery and find new flu medicine?" I came across Dr. Rommie Amaro of the University of California, San Diego, and she was willing to let me work in her computation lab.

Chen then goes on to describe his activities of using the computer to screen a half million chemical compound, separating out 237 likely candidates, and testing each of them in a "wet" lab (that is, a "traditional biology lab) to identify six that are worthy of animal studies.

With his good brain, some tutoring from a professor, and the help of computer technology, a high school student was able to do cutting edge research in medicine. What a marvelous learning experience!

Genetic Engineering

Quoting from the Wikipedia:

> Genetic engineering (GE), also called genetic modification, is the direct manipulation of an organism's genome using biotechnology. New DNA may be inserted in the host genome by first isolating and copying the genetic material of interest using molecular cloning methods to generate a DNA sequence, or by synthesizing the DNA, and then inserting this construct into the host organism.

Genetic engineering equipment has now reached the stage that international and national student contests are held. Paraphrasing a story about a Genetic Engineering competition for college students in *The Seattle Times* (Hodson, 11/7/2011):

> One project created enzymes that could convert sugar into diesel fuel.
>
> The other engineered bacteria that could help people digest gluten.
>
> Both projects constitute cutting-edge science. They came from a team of undergraduate students at the University of Washington. The projects garnered the team—and the university—a world-championship prize at an annual competition at the Massachusetts Institute of Technology.

In brief summary, computer technology has reached a stage in which "mere" undergraduate college students can do such projects as "building two enzymes that could be put into bacteria to convert sugar into diesel fuel." What a marvelous learning experience!

Current Research in Materials Science

A *Scientific American* article by Gerbrand Ceder and Kristin Persson describes how the computer has changed the entire field of materials science (Ceder & Persson, 11/19/2013).

Quoting from the article:

> In 1878 Thomas Edison set out to reinvent electric lighting. To develop small bulbs suitable for indoor use, he had to find a long-lasting, low-heat, low-power lighting element. Guided largely by intuition, **he set about testing thousands of carbonaceous material**s—boxwood, coconut shell, hairs cut from his laboratory assistant's beard. After 14 months, he patented a bulb using a filament made of carbonized cotton thread. [Bold added for emphasis.]

Here is a short summary of the article:

> Engineered materials such as chip-grade silicon and fiber-optic glass underpin the modern world. Yet [as illustrated by Thomas Edison's work] designing new materials has historically involved a frustrating and inefficient amount of guesswork.
>
> Streamlined versions of the equations of quantum mechanics—along with supercomputers that, using those equations, virtually test thousands of materials at a time—are eliminating much of that guesswork.
>
> Researchers are now using this method, called high-throughput computational materials design, to develop new batteries, solar cells, fuel cells, computer chips, and other technologies.

The Tool Is the Teacher

The message that I take from these three examples is that the computer being used in tool mode helps to create powerful learning and research experiences that in some sense circumvent and/or greatly speed up many years of conventional education and time spent gaining experience.

I find this to be an interesting way to think about teaching machines. We know, of course, that a teaching machine can be designed to help students to better solve the problem of learning certain content. I have always wondered about the fact that, for a teaching machine to be effective, it has to in some sense "know" the content it is teaching. This idea is obvious in the traditional drill and practice in math facts programs that generate random problems, present the problems to a student, and check the student's answers against answers generated by the computer.

But, today's computers can solve a steadily increasing range of problems—and many of these are beyond the capabilities of a human being. So, what should students be learning? Let me repeat a sentence from the Ceder and Persson quote given earlier:

> Streamlined versions of the equations of quantum mechanics—along with supercomputers that, using those equations, virtually test thousands of materials at a time—are eliminating much of that guesswork.

Quantum mechanics is a very challenging field of study. The development of streamlined versions of the equations of quantum mechanics, and of computers that could solve these equations, produced a new "medium" that could be mass-produced and widely distributed. Students can use these new types of teaching machines to do cutting edge research. This provides an excellent example of a tool being a teacher.

Here are more examples that I like to use in illustrating "The Tool is the Teacher." I have numbered them as a continuation of the seven examples in the previous chapter..

8. As mentioned in the previous chapter, the Web and the large amount of artificial intelligence incorporated in modern search engines is a powerful aid to learning. Through using this tool, one learns to use the tool. One's personal Web-searching skills improve. And, over the years, both the amount of content in the Web increases and the quality of search engines improves.
9. How can a person who does not know how to play a musical instrument learn to compose for that instrument? (And, consider the challenge an orchestral composer faces.) We now have powerful computer programs and music generation equipment that can perform the music a person is composing. The tool plays an important role in the teaching. Moreover, the tool can perform the final music that is composed. What a marvelous learning experience!
10. Recently I have been reading Michio Kaku's book, *The Future of the Mind* (Kaku, 2014). His focus is on human consciousness and many of the cutting edge technologies that are now available or are soon likely to be. He discusses "mind reading"—input and output connectivity between a computer brain and a human brain.

    Here is a Kaku quote about this idea: "Stephen Hawking, my colleague, is totally paralyzed, and he has a chip in his right [eye] glass. Next time you see him on television, look in his right frame, and you see a brain sensor that picks up radio from his brain and allows him to type mentally."

    Michio Kaku predicts that such technology will come into widespread use in about ten years. This technology requires both that the tool teach its user and that the user teaches its tool.
11. We have long had computer-aided design and computer-aided manufacturing equipment. A skilled operator of CAD-CAM equipment both designs a component of a product and also produces instructions that control a computerized machine to produce the component. An automated loom provides an excellent example.

    As another example of CAD-CAM equipment, we now have relatively inexpensive robot-like 3-D printing machines that function much like a laser printer. The printers use "ink" that consists of various types of plastics and metals that can be used to build physically solid products by "printing" one very thin layer at a time. These three-dimensional printers allow sculptor artists to both design and produce their sculptures. A recent article in *Campus Technology* suggests that widespread use of this technology in schools and higher education is still a decade away (Nagel, 8/19/2014). Current uses in schools are being "hyped" and these certainly can be fun and interesting for students. Learn about a possible future of 3 D printing in a March 18, 2015 TED Talk at http://time.com/3748591/3d-printing-terminator-ted-talks/.

12. There are many disciplines of study in which a computer and/or computerized robot is an important aid to representing and solving discipline-related problems. Nowadays, the frontiers of computer use in the various disciplines focus on a human accurately specifying a problem to be solved or a task to be accomplished. That is, a human poses a clearly stated problem or asks a carefully stated question. Given such a specification or question, the computer or computerized robot takes over the detailed task of figuring out to solve the problem or accomplish the task. A dialogue between the human and the computer system will likely occur. The human has to learn the types of questions the computer system can answer and how to state questions in a format that the computerized robot is designed to handle. The programmers work to improve the human-machine communication system. The Watson computer system that performed so well in a 2011 Jeopardy contest illustrates progress that is occurring in the types of questions a computer system can "understand" and answer.

Final Remarks

Every academic field of study and research is developing computer tools that are specifically designed to aid students and researchers in its field. These tools have built-in knowledge and skills that are part of the fundamentals of the discipline. As these tools become more powerful and essentially indispensable to a specific discipline of study, they lay the groundwork for the tool becoming the teacher. This trend is now well started. I believe over the next few decades it will become a dominant force in education. Much in the manner that we now expect all students to learn to use computer search engines, in the future we will expect students to learn to use the specialized computerized tools now being developed in the various disciplines the students study.

References

Ceder, G., & and Persson, K. (11/19/2013). How supercomputers will yield a golden age of materials science. *Scientific American*. Retrieved 8/21/2015 from http://www.scientificamerican.com/article/how-supercomputers-will-yield-a-golden-age-of-materials-science/.

Federman, M. (7/23/2004). What is the meaning of the medium is the message? Retrieved 8/22/2014 from http://individual.utoronto.ca/markfederman/article_mediumisthemessage.htm.

Hodson, J. (11/7/2011). UW team wins genetic-engineering contest. *The Seattle Times*. Retrieved 8/22/2014 from http://seattletimes.com/html/localnews/2016713770_igem08m.html.

Kaku, M. (2014). *The future of the mind: The scientific quest to understand, enhance, and empower the mind.* New York: Doubleday.

Kuchment, A. (10/21/2013). Teenager creates new flu drugs. *Scientific American.* Retrieved 8/22/2014 from http://blogs.scientificamerican.com/WSS/post.php?blog=11&post=1445.

Nagel, D. (8/19/2014). Widespread 3D printing in classrooms still a decade out. *Campus Technology.* Retrieved 8/27/2014 from http://campustechnology.com/articles/2014/08/19/widespread-3d-printing-in-classrooms-still-a-decade-out.aspx.

Chapter 16

[*IAE Newsletter - Issue 149, November, 2014*]

Innovating Minds—What Students Need for the Future

Marcus Conyers
Center for Innovative Education and Prevention

> "Everything around you that you call life was made up by people that were no smarter than you, and you can change it, you can influence it, you can build your own things that other people can use." (Steve Jobs; inventor; 1955–2011.)
>
> "We are convinced the world will increasingly be divided between high imagination-enabled countries, which encourage and enable the imagination and extras of their people, and low imagination-enabling countries, which suppress or simply fail to develop their people's creative capacities and abilities to spark new ideas, start up new industries and their own 'extra.'" Thomas Friedman and Michael Mandelbaum; *That Used to Be Us* (2011).

The present and future envisioned in these two quotes sound both a challenge and an opportunity. The words of Steve Jobs in particular capture the essence of the mindsets students will need for the future as they take their place in a world where automation and outsourcing of routine work are transforming the landscape and their career prospects. I have had the enormous privilege of teaching cognitive strategies that support creative thinking to students from kindergarten through college age and have been inspired by their incredible potential to learn, to innovate, and to solve problems.

I recall one class in particular on a day when I was sharing a strategy for fostering creative collaboration that I call *story scape*. The students were mostly from low-income families, the children of migrant farm workers, with limited English proficiency and background knowledge. They were bright-eyed, brimming with potential, and a joy to work with, though they lacked confidence in their ability to write a story. With the story scape strategy, I act out a story based on the creative input from all students. Usually the stories end up with my character in great peril. My goal is to make sure that even shyest students contribute and that all experience the thrill of success fed by the release of dopamine in their brains over this positive, energizing experience.

We began with the invitation to complete the opening line, "Once upon a time there was a man who was wearing … ?"

"An Elvis Pressley outfit," the first contributor suggested.

"And he was looking for a … ?"

"Guitar," piped up a previously reluctant learner who was now at risk of not being the coolest kid in class, because his friend who had made the first suggestion was now the center of attention.

"And then he heard a terrifying sound behind him, and he began to run because he was being chased by … ?"

"A giant frog!" exclaimed another student.

"A giant *purple* frog!" supplied another.

As I acted out the part of a man dressed as Elvis, looking for a guitar as he is pursued by a giant purple frog, I asked the students, "What happens next?"

"He trips over the guitar, and the frog is going to get him!" This suggestion was greeted by peals of delighted laughter.

"OK, now what creative way can he solve his problem?" I asked.

The room fell silent, as every brain strained for an innovative solution to this dilemma. Some students looked pensive and others a bit anguished, and I could almost see them playing out various scenarios before their minds' eyes (which is itself a strategy to facilitate creative thinking!).

In a quiet voice, a shy girl who had yet to speak said, "The Elvis man picks up the guitar and sings the giant purple frog a lullaby, so he goes to sleep."

Wow.

I was stunned by how perfect her solution seemed, and so were her teacher and classmates. Our silence was broken by a great spontaneous round of applause. Then the excited students set out to write their version of the story, adding details about the characters, plot, plight, and resolution.

This experience captures a great deal of what has fueled my passion for developing strategies to cultivate the cognitive skills that underpin innovative thinking and entrepreneurial doing so that every child is empowered to create his or her own story.

'Sputnik Moment': Urgent Need to Learn and Teach Creative Thinking Skills

> "The problem is that there are only 1.2 billion full-time, formal jobs in the world. This is a potentially devastating global shortfall of about 1.8 billion good jobs. It means that global unemployment for those seeking a formal good job with a paycheck and 30+hours of steady work approaches a staggering 50%." Jim Clifton, *The Coming Jobs War* (2011, p. 2).

In *That Used to Be Us*, Friedman and Mandelbaum (2011) make the case that for organizations to survive and individuals to thrive, each of us must harness the power of imagination and enhance our capacity for creativity and innovation to deliver that necessary something "extra." We can better prepare students for that uncertain future through explicit instruction on how and when to use cognitive skills that are the everyday tools of innovators and entrepreneurs so that they may take their place in what Richard Florida (2014) calls the *creative class*. At the core of the creative class are people whose "chief economic function is to create new ideas, new technology, and new creative content." Developing this skill set is imperative for success in an evolving and devastatingly tight job market:

- The creative class makes up one third to nearly one half of the workforce in the economically advanced nations of North America, Europe, and Asia. It represents about 40 million jobs in the United States.
- Even as traditional skills are being outsourced or rendered obsolete through automation, creative and innovating skills are hot commodities.
- The current limited opportunities for education and training in these skills contribute to the deepening economic divide—the difference between landing good-paying jobs with opportunities for advancement and minimum-wage work.
- Underscoring the critical need to empower this generation with the creative and innovative thinking skills that will increase their opportunities.
- An Adobe Systems poll of 5,000 people on three continents reports that 80% see unlocking creative potential as crucial to economic growth. But only 25% feel they are living up to their creative potential.
- A recent IBM survey of more 1,500 CEOs reports that creativity is the single most prized competency among employees and managers.
- Research on creativity—how well people generate ideas, how original their ideas are, and how they persist in the work of turning ideas into effective action—shows a steady decline in skills related to creativity and innovation over the past 20 years.

In an era where virtually all new jobs created are in small and mid-sized enterprises, we must find ways to nurture innovative thinking and entrepreneurial mindsets in today's workforce and in students who will be the future job candidates—and proprietors—of those enterprises. As Florida puts it, "Prosperity in the Creative Age turns on human potential. It can only be fully realized when each and every worker is recognized and empowered as a source of creativity—when their talents are nurtured."

In 1957, the Soviet Union launched the first human-built satellite into orbit around the Earth—and so began the space race with the United States that spawned a remarkable decade of engineering and exploration ending in astronauts walking on the moon. The current creativity crisis should be our wake-up call to better prepare students to become tomorrow's innovators. Unfortunately, current education and training systems in the United States and other industrialized nations focus on developing analytic skills and the retention of facts, which are necessary but no longer sufficient for engaging young minds and preparing them to thrive in the working world. For many of us, capacities for creativity are not cultivated and may even be discouraged in the process of our education. One study, for example, found that the vast majority of young children start school exhibiting high levels of creativity, which decline steadily throughout the school years into adulthood, leading one researcher to conclude that "non-creative behavior is learned." Research indicates that creativity has declined steadily in the United States since the 1990s across key domains (Kim, 2012).

However, emerging research from fields such as mind, brain, and education—and studies of creativity—indicate tremendous opportunities for nurturing the creative capacities of children and equipping students and adults with a cognitive toolkit of skills to enhance and act on their innovative thinking.

Awakening the Brain's Creative Potential

The word *education* is derived from the Latin root *e-ducere*, which means "to lead out." Experiences literally shape the brain, and the neurocognitive systems associated with creative thinking are malleable. Furthermore, creativity is relatively independent of traditional measures of human potential such as IQ. New research is also overturning the common myth that creativity is a special gift that only a lucky few possess. The profound implication of these findings is that almost all of us have the capacity to learn to be more creative and innovative. It is now possible to create learning environments and opportunities in classrooms and workplaces that lead out more of the creative potential of all learners. In our work across North America and Europe and around the world, one thing has become clear: In the hyper-connected innovation age, it is essential that we cultivate the cognitive skills for identifying opportunities and creating, evaluating, and applying new ideas that generate unique, relevant, added value. We need to be both innovative thinkers and entrepreneurial doers. We need to develop *innovating minds*.

Every day learners of all ages come to school with their brains powered by some 87 billion to 100 billion neurons. Through brain imaging and other technologies, neuroscientists have begun to identify key neural systems involved in the creative process. The science of creative cognition is expanding our understanding of the cognitive skills that drive the creativity. At the same time useful theories can be applied in the process of cultivating creative and innovative thinking.

Sternberg (1985; Sternberg & Lubart, 1995) describes three key abilities that can be developed to increase creative thinking skills. In essence, these three abilities underpin what innovating minds do in terms of creative thinking and entrepreneurial doing:

- **Synthetic ability** refers to generating novel, creative ideas. People with well-developed synthetic thinking are recognized as innovative because they make connections that others don't recognize.
- **Analytic ability** refers to critical thinking and problem-solving skills resulting from the identification and evaluation of possible solutions. Analytic thinking supports creativity by weeding out bad ideas and highlighting the most promising possibilities. Innovating minds rely on analysis to consider all angles of a creative idea and test it out.
- **Practical ability** refers to translating ideas into reality. Innovators use practical ability to make an abstract concept concrete, to demonstrate its usefulness, and to identify the people most likely to benefit from its use.

Different "brain states," or ways of thinking, can be applied to enhance creative and innovative thinking. Some of these states may not come easily to everyone, but they can be cultivated over time. We can train our brains to become more creatively productive and to proactively apply innovative ways of thinking to creative challenges (Carson, 2012).

Neuroscientists have identified two key brain networks, referred to as the *executive attention* and *default mode* networks, involved in creative thinking. The executive attention network, connecting outer regions of the prefrontal cortex to areas in the posterior region of the parietal lobe, is active when cognitive control is required in the problem-solving, evaluation, and implementation phases of innovation. In contrast, the default mode network, which some researchers refer to as the "imagination network," is involved in "constructing dynamic mental simulations based on personal past experiences such as used during remembering, thinking about the future, and generally when imagining alternative perspectives and scenarios to the present" (Kaufman, 2013). This network involves areas in the prefrontal cortex, temporal lobe, and parietal cortex, drawing on information stored in long-term memory and on regions associated with personal memories. Studies suggest that this network is highly active during the brainstorming and free association phases of creative thinking. As research continues on which areas of the brain are most involved in creative cognition, we may learn more about how and when to tap into these networks to come up with innovative ideas and then to evaluate and implement them.

Game-Changing Opportunity

To thrive in the global innovation economy, today's students need to become creative thinkers and entrepreneurial doers who can collaborate, create, and implement new ideas that add relevant added value. They need to become skilled in identifying problems and opportunities, dreaming up and dialoguing possible solutions, elaborating and enhancing the best ideas, and applying and refining them in response to feedback. All of these skills can be taught and learned. Students have great untapped potential to become more creative and to make the most of their creative, analytic, and practical abilities. The question is whether we have the will to provide the game-changing opportunity to cultivate the innovating minds that students need for the future.

References

Carson, S. (2012). *Your creative brain: Seven steps to maximize imagination, productivity, and innovation in your life.* San Francisco: Jossey-Bass.

Clifton, J. (2011). *The coming jobs war.* Omaha, NE: Gallup.

Florida, R. (2014). *Rise of the creative class.* New York: Basic.

Friedman, T.L., & Mandelbaum, M. (2011). *That used to be us.* New York: Farrar, Straus, & Giroux.

Kaufman, S.B. (2013, August 19). The real neuroscience of creativity [Beautiful Minds blog]. *Scientific American.* Retrieved from http://blogs.scientificamerican.com/beautiful-minds/2013/08/19/the-real-neuroscience-of-creativity/.

Kim, K.H. (7/10/2012). Yes, there is a creativity crisis. *The Creativity Post.* Retrieved from http://www.creativitypost.com/education/yes_there_is_a_creativity_crisis.

Sternberg, R.J. (1985). *Beyond IQ: A triarchic theory of intelligence.* Cambridge, England: Cambridge University.

Sternberg, R.J., & Lubart, T.I. (1995). *Defying the crowd: Cultivating creativity in a culture of conformity.* New York: Free.

Vartanian, O., Bristol, A.S., & Kaufman, J.C., eds. (2013). *The neuroscience of creativity.* Boston: MIT.

Part 4: Explorations that Look Towards Future Possibilities

Our educational system consists of informal and formal components, and these overlap. Thus, for example, we have long known that as the general education of parents increases, the education of their children benefits. At the same time, educated parents demand more of their children's schools and their teachers.

The first part of this book emphasized changes going on throughout the world, and especially emphasized changes in technology. Our current informal educational system is being strongly impacted by technology. Our formal schooling system is making rapid progress toward incorporating appropriate Teaching Machines into schooling. A few decades from now we will look back with wonder about how rapidly schooling has changed.

But, right now, there is considerable conflict among the various stakeholders engaged in these change processes.

For example, consider the conflict between parents and their children about how much time children should be "allowed" to make use of the media, computers, computer games, social networking, and so on. What can human teachers do much better than Teaching Machines, and vice versa? How can we determine if our children are getting a good education that prepares them for responsible adulthood and lifelong learning in our rapidly changing world?

17. David Moursund. Folk Computing and Folk Mathing.
18. Sean Sylwester. The Role of Video Games in the Education of Young People.
19. David Moursund. Sugata Mitra's Thoughts on the Future of Learning.
20. Linda Rappel. Writing as an Important Challenge in Adult Education.
21. David Moursund. The Future through Quotations.

Chapter 17

IAE Newsletter - Issue 154, January, 2015

Folk Computing and Folk Mathing

David Moursund
Emeritus Professor of Education
University of Oregon

> "If you want to teach people a new way of thinking, don't bother trying to teach them. Instead give them a tool, the use of which will lead to new ways of thinking." (Richard Buckminster Fuller; American engineer, author, designer, inventor, and futurist; 1895-1983.)

You have heard about folk dancing and folk music. But, how about folk computing and folk mathing? They may seem to you as long-stretch analogies in the use of the term *folk*. However, these analogies offer interesting insights into an important part of the future of education. This IAE newsletter provides a brief introduction to the long-established discipline of folk math (often called street math) and uses this as a springboard into a discussion of folk computing.

Children growing up in an environment containing considerable folk music or folk dance learn these two long-time important parts of human culture without the benefit of formal schooling. For the most part, they learn by observation, imitation, participation, and just plain playing. This oral tradition of folk learning predates the development of reading and writing.

Folk Math

Most students have learned quite a bit of math long before beginning kindergarten or the first grade. This is especially true for children growing up in homes in which numbers are a routine part of daily conversation.

My long-time colleague Gene Maier wrote extensively about folk math (Maier, 1976) more than 35 years ago. His papers provide numerous examples of people with little or no formal schooling solving the types of math problems arising in their jobs as carpenters, millwrights, plumbers, sheet metal workers, and so on.

One of the key ideas in Maier's writings is that children can and do learn a lot of math without the benefit of formal schooling. Quoting from Maier (1976):

> Woody Guthrie defined folk music as "music that folks sing." In that same way, folk math is math that folks do. Like folklore, folk math is largely ignored by the purveyors of academic culture—professors and teachers—yet it is the repository of much useful and ingenious popular wisdom. **Folk math is the way people handle the math-related problems arising in everyday life.** [Bold added for emphasis.]

The general topic of folk math is often discussed in the context of street children in impoverished countries learning "street math" that they need in selling newspapers or other goods and services on the street, and feeding and clothing themselves. My 1/5/2015 Google search of the expression Brazil street math produced over 2 million hits. See, for example, the article by Keith Devlin (May, 2005).

Folk (Street) Computing

My recent Google search of the term *folk computing* produced about 5,700 hits. I browsed through the first 100 results, and essentially all referred back to a 2001 paper (Borovoy, et al., 2001). Quoting from the paper:

> In this paper, we introduce Folk Computing: an approach for using technology to support co-present community building inspired by the concept of folklore. We also introduce a new technology, called "i-balls," whose design helped fashion this approach.
>
> We are interested in **how technology can support face-to-face communication and community building.** [Bold added for emphasis.]

Notice the last sentence. The aim of the project was to create a new computer communication environment in which children could create and share "balls of information" (i-balls). The article mentions that the project was built on their previous five years of development work on folk computing. However, the i-ball project is quite different from my concept of folk computing.

In my opinion, the history of folk computing (but not its designation as "folk computing") goes back to the 1940's and 1950's when the first computer games and early programming languages such as FORTRAN were being developed. FORTRAN was designed for adults to help them solve problems in engineering, physics, and other sciences. On their own, secondary school students discovered FORTRAN programming to be a sort of game in which they could direct the operations of a computer to do tasks of interest to them.

I envision folk computing as an entirely different concept than the i-ball project. I am interested in taking the ideas of folk math and applying them to children learning to use computers. Many of today's children use computerized electronic toys, computerized games, tablet or laptop computers, and Smart Phones before they enter kindergarten or the first grade. The acquisition and transmission of learning of this type of computer use, knowledge, and skills fits neatly into the "folk" category.

Folk computing learning styles are somewhat like those used by children of earlier generations in learning folk music and folk dance by observation and imitation. However, children learning folk computing have an added advantage—computers can be used in a self-study, self-play, anytime, anywhere mode, and they provide nearly instant feedback. For example, think about a child learning to take pictures using a digital camera, a quite sophisticated computerized device. The cost of this fun, learn-by-doing activity may be only a few instructions from a relative or friend followed by a period of trial-and-error and feedback from self and others.

I am amazed by the skills that children can develop through playing with computers. The software they are playing with might be a game. But it might also be a creative art environment, a building block environment, a word-processing environment, an information retrieval environment such as the Web, a music creation and/or editing environment, and so on. Computer apps provide children of all ages with fun, interesting, challenging opportunities to do things, receive feedback, and make changes to better achieve whatever they are trying to accomplish.

The idea of folk computing extends to adults of all ages. On a worldwide basis, last year about a billion Smart Phones were produced and sold. Most adults purchasing these cell phones may initially have had a brief amount of instruction from a sales clerk or from friends. (It is rumored that some people actually read the manual.) They also learned to use them through transfer of learning from their previous skills in using phones, cameras, video games, accessing music and other information, GPS, and so on. Few, if any, received formal instruction in a "school" setting.

What this illustrates is the power and potential of folk computing in the education of students of all ages. If useful new products have good user interfaces, people will learn to use the products by using the products. See the quote from Buckminster Fuller at the beginning of this newsletter.

Folk Computing in Education

Educational researchers are well aware of student interest in—indeed, sometimes addiction to—computer games and social networking learned through folk computing. They ask, "How can we bring this intrinsic motivation and accompanying learning into our traditional, formal schooling system?" Thus, there are now many research and development projects being conducted jointly by educational researchers/designers and computer entertainment companies.

I find it interesting to think about the long-term implications of extending the basic ideas and uses of folk computing into our formal educational system. **For me, this raises the question, "What content might best be taught by folk computing and what might best be taught by more formal computer teaching systems and/or human teachers?"** See Moursund (2014a, 2014b.)

In my mind, I think of the meaning of "best" both in terms of cost effectiveness and in terms of preserving human values and the essence of us as human beings. The socialization and social development of children is a very important goal of education. Every subject we teach in schools is rooted in human history and values. This is true even in math, one of my favorite subjects. One of the more important math education books published in the 20th century is *Mathematics, a Human Endeavor* (Jacobson, 1982).

My question raised above about the role of folk computing in education has no simple answers, and the answers we develop will change over time through continued progress in the capabilities of computer technology and the changing educational needs of people.

The Tool Is the Teacher

In two recent IAE newsletters about the future of teaching machines, I explored the idea that a tool itself can be thought of as an aid to learning to use that tool (Moursund, 2014a, 2014b). Computerized tools can be specifically designed both to help solve particular types of problems or accomplish particular tasks, and also to help their users learn to use the tools effectively. In my two newsletters I built on Marshall McLuhan's statement that "the medium is the message" and on the quote from Buckminster Fuller given at the beginning of this newsletter. I summarized the theme I developed by the statement, "The tool is the teacher."

The next three sections provide some insights into the folk computing tool as a teacher.

Sugata Mitra

What can children learn when they are provided access to a computer but with little or no instruction about what it is and what it can do? Sugata Mitra began to explore this idea in 1999. Quoting from the Wikipedia article on Mitra (n.d.):

> In 1999, the [Sugata Mitra's] Hole in the Wall (HIW) experiments in children's learning, was first conducted. In the initial experiment, a computer was placed in a kiosk in a wall in a slum at Kalkaji, Delhi and children were allowed to use it freely. The experiment aimed at proving that children could be taught by computers very easily without any formal training. Mitra termed this Minimally Invasive Education (MIE). The experiment has since been repeated in many places; HIW has more than 23 kiosks in rural India. In 2004 the experiment was carried out in Cambodia.

View two *TED Talks* by Mitra by clicking here and here. He won a $1 million prize from TED that he is using to continue his research.

Research on Educational Computer Games

My Google search of the expression *educational computer games* research produced over 290 million hits. There are a number of major research centers in the U.S. and other countries that are doing research on video games in education. The Education Arcade at MIT provides an excellent example. One of their major successes is the development and widespread dissemination of a "modern" graphics-oriented programming language for children. Children from throughout the world share their programming projects and ideas through this MIT website.

Here is an example of current work at the University of Wisconsin, Madison:

> Designed to measure children's learning in real time while rewiring their brains to help them be more empathetic, Crystals of Kaydor [a new game] offers a potentially transformative response to two cutting-edge questions now being debated in the world of testing: whether digital games can effectively blur the line between instruction and assessment and how educators can better gauge children's social and emotional skills (Herold, 8/6/2013).

Notice the emphasis on social and emotional skills. These are certainly an important aspect of a good education—but they are not directly taught in most schools. Notice also that improving competence in a game is a good measure of learning that is occurring in the game. The line between instruction/learning and assessment is blurred in computer game environments.

Sherry Turkle

Folk computing can be likened to a bed of roses. It is sweet, but thorny. Sherry Turkle is a professor in the Program in Science, Technology and Society at MIT and the founder and director of the MIT Initiative on Technology and Self. Quoting from the introduction to her *TED Talk* (Turkle, April, 2012):

> Described as "the Margaret Mead of digital culture," Turkle has now turned her attention to the world of social media and sociable robots. As she puts it, these are technologies that propose themselves "as the architect of our intimacies." In her most recent book, *Alone Together: Why We Expect More From Technology and Less From Each Other*, Turkle argues that the social media we encounter on a daily basis are confronting us with a moment of temptation. Drawn by the illusion of companionship without the demands of intimacy, we confuse postings and online sharing with authentic communication. We are drawn to sacrifice conversation for mere connection. Turkle suggests that just because we grew up with the Internet, we tend to see it as all grown up, but it is not: **Digital technology is still in its infancy and there is ample time for us to reshape how we build it and use it.** [Bold added for emphasis.]

I believe the most important point in her *TED Talk* is that people are being greatly changed by the computer. If you have ever seen a group of children sitting in a room and communicating with each other through texting or a social network, you have seen the idea of *Alone Together* (Turkle, 2011). Many children are growing up without gaining good skills in face-to-face voice communication.

Final Remarks

Folk computing has added a new dimension to education. It is making a major change in children, and it brings children into our schools who are quite different from children of earlier years. Our schooling system faces a major challenge as it works to design and implement an educational system that incorporates the best features of what human teachers can provide with the best features that computer technology can provide.

Although the history of the use of computers for teaching and learning in schools is now over 50 years old, we are still at the beginning of integrating computer technology into education. Folk computing is producing children who enter formal schooling knowing far more about certain aspects of computers than do most of their teachers. Our formal educational system faces a future of continuing change as it is trying to keep up with these changes in our students, as well as in research and development in computer technology, brain science, and a host of other major worldwide changes.

References

Borovoy, R., Silverman, B., Gorton, T., Klann, J., Notowidigdo, M., Knep, B., & Resneck, M. (2001). Folk computing: Revisiting oral tradition as a scaffold for co-present communities. *MIT Media Lab*. Retrieved 1/24/2015 from https://llk.media.mit.edu/papers/folk-computing.pdf. [Editor's note: When I click on this link I get an error message. When I copy the link and paste it into my browser it works fine.]

Devlin, K. (May, 2005). Street mathematics. *Devlin's Angle*. Retrieved 1/5/2015 from https://www.maa.org/external_archive/devlin/devlin_05_05.html.

Herold, B. (8/6/2013). Researchers see video games as testing, learning tools. *Education Week*. Retrieved 1/17/2015 from http://www.edweek.org/ew/articles/2013/08/07/37games_ep.h32.html?tkn=QYVFFx%2BJwJ4Tw5%2F7jjqR9nE48RF2gSXDR71y&cmp=clp-edweek.

Jacobson, H. (1982). *Mathematics, a human endeavor: A textbook for those who think they don't like the subject.* New York: Freeman.

Maier, E.A. (1976). Folk math. *Gene's corner and other nooks & crannies: Perspectives on math education*. Salem, OR: The Math Learning Center. Retrieved 1/5/2015 from http://iae-pedia.org/Folkmath.

Mitra, S. (n.d.). Wikipedia. Retrieved 1/14/2015 from http://en.wikipedia.org/wiki/Sugata_Mitra.

Moursund, D. (2014a). Education for students' futures. Part 14: The future of teaching machines. *IAE Newsletter*. Retrieved 1/12/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-145.html.

Moursund, D. (2014b). Education for students' futures. Part 15: The future of teaching machines. *IAE Newsletter*. Retrieved 1/12/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-146.html.

Turkle, S. (April, 2012). Connected but alone. *TED Talks*. Retrieved 1/12/2015 from https://www.ted.com/speakers/sherry_turkle.

Turkle, S. (2011). *Alone together: Why we expect more from technology and less from each other*. New York: Basic.

Chapter 18

IAE Newsletter - Issue 144, August, 2014

The Role of Video Games in the Education of Young People

Sean Sylwester
Oregon State University Student
Electrical Engineering

The discussion of Kaku's work in Chapter 13 suggested that the punch line is the central element in jokes. Our understanding of the physical and social world suggests how a joke's narrative will probably end. Laughter is the release when the punch line provides an unexpected conclusion. Our survival as humans depends on our ability to foresee and effectively respond to unexpected events. Humor helps to develop this capability in young people in a pleasant, non-threatening manner that we maintain throughout adult life. Gossip and play/games play similar roles in that both deal with unexpected outcomes and the responses that people develop.

Sean Sylwester's Perspectives

Play and games occupy much of early life. Play is unstructured behavior as children master arm/leg movements, share toys, interact with unrelated friends, etc. Children soon begin to compare their capabilities with others and that's what organized rule-bound games and sports do. Most of us enjoy games at one level or another throughout life. Video games have already expanded substantially during the 21st century and this expansion will seemingly continue.

I have long been fascinated by video games. I'll begin my university program in electrical engineering this fall, hoping to participate in the probable advances that will occur in simulations and video game technology. What follows is the role that I believe video games played during my earlier years—the things I thought I learned better through video games than during school activities.

Perhaps the most important thing for my generation is that video games became our initial gateway to learn about computers. We have played computerized video games as long as most of us can remember. Video games gave us something that was fun to do on the computer. They thus encouraged us to explore the technology in a way that we probably never would have done otherwise. Video games allowed us to become comfortable with the basic technology of computers. Computers and other forms of electronics are all around us, and their impact on our society will only increase. The natural development of this skill was thus invaluable for my generation.

In addition to providing me with a fun way to explore computer technology, video games also helped me in my mental development. Video games supplemented my education in many ways, and sometimes taught me entirely new things. For example, school instruction rarely encouraged me to solve puzzles. Math and physics classes were based on strict formulas, and teachers tended to discourage us from thinking creatively to solve a problem. Teachers would usually show us one specific way of doing a problem, and then ask us to use the formula in solving the problems they gave us. They rarely explained the logic behind the solution. Video game challenges were fortunately able to fill in this gap for me.

Many current video games have some element of a puzzle or unexpected twists incorporated within them. These include "pure" puzzle games in which solving the puzzle is the entire point of the game, and a staggering variety of these games is on the market for anyone and everyone–first-person or third-person, 3D or 2D, fast-paced action or slow-paced strategy, physics-based or not. Each new game uses new concepts and explores new ideas, encouraging the player to think in different ways. Many popular video games now include puzzles as a secondary focus. These games encourage and reward players who use creativity in their strategy. Developers realize that they must move the field forward in order to sell their games to increasingly sophisticated players.

The development of team-based communicative and collaborative skills is also central to many current video games. I often found this lacking in school instruction. These skills were used in extracurricular activities such as team sports and out-of-school clubs, but they weren't always demonstrated effectively within classrooms. Sports tended to be run by coaches who expected players to do what they were told. I lost interest in team sports at about the fourth grade, and instead learned many social skills through multiplayer video games.

Most Internet games today are multiplayer (see *multiplayer video games* in Resources). Many players connect to the same game over the Internet, and the teams that emerge have to then figure out how to work together towards the video game goal, generally against a competing team of players. Players can generally communicate with each other by keyboard interaction or by talking over a microphone. These kinds of games are generally "real time" so quick action is important. The team with better collaboration, coordination, and communication generally wins. Development of these skills (and sometimes fast typing) are the keys to success, but the games have many formulas. School instruction does often incorporate group projects, but it is rarely the principal focus of the lesson. Like others who also stopped playing sports, video games played a very influential role in developing my social and collaborative skills. So whether I played online with friends I knew in real life or was matched with random players from across the country, the games developed my mental, physical, and social skills in the same way as sports and other extracurricular activities did for my classmates (see *multiplayer video game explanation* and *cooperative multiplayer video game explanation* in Resources).

Classroom instruction seems to have a built-in rigidity. Although most students learn in different ways and at an individual pace, teachers have to work with the whole group, so instruction is often focused on the average students or even on the lowest level students. This not only jeopardizes the learning of students who might not learn in that way, but it also risks losing the focus of students who want to learn at a faster pace.

Video games are thus a more versatile teaching tool, because they let players work at their own individual pace. They're designed to fit individual learning. Lecture or discussion based classes work pretty well for most students although this is becoming a contested point (Kagan, June, 2014). Most instruction occurs this way. I had no trouble learning in this style, but I've found that I learned much more quickly and deeply, and I retained the information much more easily, when I learned the concepts on my own without disapproval from teachers. Video games provided my generation with that non-threatening option.

Video games can help some students learn in a more efficient way, more easily maintaining the student's motivation for learning. Struggling to learn in a way that doesn't suit a particular student, or being made to work much faster or much slower than the student would prefer often diminishes their motivation in school. Solving many of these major problems through supplementary classroom video games could help all students succeed in their own way. Understanding video games as a positive form of learning and building on it could do wonders for school test scores and high school graduation rates. (See Another Perspective below.)

References

Cooperative multiplayer video game explanation. Retrieved 8/11/2014 from http://en.wikipedia.org/wiki/Cooperative_gameplay.

Kagan, S. (June, 2014). Education for students' futures. Part 9: The problem is not the cell phone. *IAE Newsletter.* Retrieved 3/27/2015 from http://i-a-e.org/newsletters/IAE-Newsletter-2014-140.html.

Multiplayer video games. Retrieved 8/11/2014 from http://en.wikipedia.org/wiki/Category:Multiplayer_video_games. (This list is now somewhat dated, but it will give you a sense of the breadth of the field. The number of multiplayer games now runs into the tens of thousands.)

Multiplayer video game explanation. Retrieved 8/11/2014 from http://en.wikipedia.org/wiki/Multiplayer_video_game.

Another Perspective

There are many good school programs that seek to solve the criticism Sean provides. Many are directed to inservice rather than to preservice teachers. That these programs tend to be well-received by teachers suggests that, once new teachers begin to teach, many seek to improve their instruction in the ways that Sean suggested

In chapter 10, Spencer Kagan describes how his very successful program developed social and collaborative skills. The elements of Susan Kovalik's successful Highly Effective Teaching program (HET) address the kinds of classroom instruction problems that Sean found through video games. See http://www.thecenter4learning.com/html/resources/hetmodel.htm.

Chapter 19

IAE Newsletter - Issue 134, March, 2014

Sugata Mitra's Thoughts on the Future of Learning

David Moursund
Emeritus Professor of Education
University of Oregon

> "If wishes were horses, beggars would ride." (English language proverb and nursery rhyme, originating in the 16th century.)

We each have our own thoughts as to what constitutes a good education and how we can improve our informal and formal educational systems so that a much higher percentage of students receive a good education.

Sugata Mitra is a computer programmer turned educational researcher who has thought deeply about these questions. Quoting from http://www.ted.com/speakers/sugata_mitra.html:

> Educational researcher Dr. Sugata Mitra's "Hole in the Wall" experiments have shown that, in the absence of supervision or formal teaching, children can teach themselves and each other, if they're motivated by curiosity and peer interest. In 1999, Mitra and his colleagues dug a hole in a wall bordering an urban slum in New Delhi, installed an Internet-connected PC, and left it there (with a hidden camera filming the area). What they saw was kids from the slum playing around with the computer and in the process learning how to use it and how to go online, and then teaching each other.

Since these initial experiments, Mitra has gained worldwide recognition for his experiments with using computers in a novel type of approach to education. Much of the content of this chapter is drawn from Mitra's Build a School in the Cloud talk (February, 2013). He begins the talk with his observations that the schools of today are much like the schools of 300 years ago:

> I tried to look at where did the kind of learning we do in schools, where did it come from? And you can look far back into the past, but if you look at present-day schooling the way it is, it's quite easy to figure out where it came from. It came from about 300 years ago, and it came from the last and the biggest of the empires on this planet [the British Empire].
>
> Imagine trying to run the show, trying to run the entire planet, without computers, without telephones, with data handwritten on pieces of paper, and traveling by ships. But the Victorians actually did it. What they did was amazing. They created a global computer made up of people. It's still with us today. **It's**

> **called the bureaucratic administrative machine.** In order to have that machine running, you need lots and lots of people.
>
> **They made another machine to produce those people: the school.** The schools would produce the people who would then become parts of the bureaucratic administrative machine. They must be identical to each other. They must know three things: They must have good handwriting, because the data is handwritten; they must be able to read; and they must be able to do multiplication, division, addition and subtraction in their head. They must be so identical that you could pick one up from New Zealand and ship them to Canada and he would be instantly functional. The Victorians were great engineers. They engineered a system that was so robust that it's still with us today, continuously producing identical people for a machine that no longer exists. The empire is gone, so what are we doing with that design that produces these identical people, and what are we going to do next if we ever are going to do anything else with it? [Bold added for emphasis.]

I am impressed by Mitra's observations. The educational system that was created by the British Empire was so robust it survived the Industrial Revolution, the development of the telegraph and telephone, the development of radios (including shortwave radios that could reach across the oceans), airplanes, television, and still more modern technology.

In recent years we have witnessed the struggle between this long-lasting educational system and the development of computers, communication satellites, "smart" phones, and fiber optic cables laid across the oceans. Mitra summarizes the current situation:

> Schools as we know them now, they're obsolete. I'm not saying they're broken. It's quite fashionable to say that the education system's broken. It's not broken. It's wonderfully constructed. It's just that we don't need it anymore. It's outdated.
>
> What are the kind of jobs that we have today? [Well, the clerks use computers. They're] in thousands [of] offices. And you have people who guide those computers to do their clerical jobs. Those people don't need to be able to write beautifully by hand. They don't need to be able to multiply numbers in their heads. They do need to be able to read. In fact, they need to be able to read discerningly.

Mitra's last sentence above gets at the world's increasing need for people who have higher order knowledge and skills. In the United States, the Common Core State Standards place considerable emphasis on such higher-order learning.

Learning without Teachers

Mitra has carried out many experiments in which students were given access to computers without the benefit of any formal instruction in their use. See the other Mitra references at the end of this newsletter to access talks he has given on this research. Perhaps my favorite examples are summarized by his two statements below. Mitra explains that he gave the children a computer that contained only English language material. He then goes on to say:

> I came back several months later and talked to the children. In an irritated voice, they said, "You've given us a machine that works only in English, so we had to teach ourselves English in order to use it." That's the first time, as a teacher, that I had heard the words "teach ourselves" said so casually.
>
> I started experimenting with other subjects, among them, for example, pronunciation. There's one community of children in southern India whose English pronunciation is really bad, and they needed good pronunciation because that would improve their jobs. I gave them a speech-to-text engine in a computer, and I said, "Keep talking into it until it types what you say."

This was another successful experiment. The children's pronunciation of English substantially improved.

Intrinsic, Non-threatening Motivation

Mitra emphasizes that the children in his experiment were intrinsically motivated. Children of widely varying ages helped each other to learn. The children could see and hear the results of the learning they were engaged in. They had some insight into the opportunities that the learning was opening up for them. Finally, and of major importance, they were not threatened by the rigidity, testing, and other demands of the formal schooling system.

This reminds me quite a bit of my childhood activities outside of school. I learned a great deal from the "kids in the neighborhood." It also reminds me of the one-room schoolhouses of many years ago. One teacher, when faced by a group of students from many different grade levels, learned to use the students to effectively help each other learn.

Mitra also emphasizes providing students with interesting and very challenging questions. Here are some examples he has used with nine-year-old children:

- If a meteorite was coming to hit the earth, how would you figure out if it was going to or not? If the child says, "Well, what? How?" You say, "There's a magic word. It's called the tangent of an angle," and leave him alone. He'll figure it out.
- What happens to the air we breathe?
- When did the world begin?

Final Remarks

Mitra strongly believes that teachers should feed students with questions, rather than with answers, and he wants students to work together to develop answers. That is a huge change from our current form of education. He closes his presentation with the statement:

> My wish is to help design a future of learning by supporting children all over the world to tap into their wonder and their ability to work together.

Mitra is now a Professor of Educational Technology at Newcastle University in the UK. He was recently awarded $1 million in seed-funding for his project from Newcastle University. His initial goal is to build a School in the Cloud, a learning lab in India, where children can embark on intellectual adventures by engaging and connecting with information and mentoring online. This learning lab will serve as a center for research into educational changes that are based on the types of ideas Mitra has been exploring for the past 15 years. Learn more about his plans at http://www.ted.com/pages/prizewinner_sugata_mitra.

References

Mitra, S. (February, 2013). Build a school in the cloud. *TED Talks.* Retrieved 2/20/2014 from http://www.ted.com/talks/sugata_mitra_build_a_school_in_the_cloud.html.

Mitra, S. (September, 2010). Sugata Mitra's new experiments in self-teaching. *TED Talks.* Retrieved 2/20/2014 from http://www.youtube.com/watch?v=dk60sYrU2RU.

Mitra, S. (January, 2010). The child-driven education. *TED Talks.* Retrieved 2/20/2014 from http://www.ted.com/talks/sugata_mitra_the_child_driven_education.html.

Mitra, S. (August, 2008). Kids can teach themselves. *TED Talks*. Retrieved 2/20/2014 from http://www.ted.com/talks/sugata_mitra_shows_how_kids_teach_themselves.html.

Chapter 20

IAE Newsletter - Issue 155, February, 2015

Writing as an Important Challenge in Adult Education

Linda Rappel
Sessional Instructor
Werkland School of Education
University of Calgary

Adult education encompasses a wide range of activities designed to meet many different goals. For example, adults interested in personal growth and enrichment might take a cooking course, attend a lecture, or improve their ballroom dancing skills.

Another group is the many adults with well-established careers who routinely take refresher courses and workshops to update their skills and to meet the requirements of their professions.

A third group, and the primary focus of this article, are those adults who have had a job, but whose job disappears. For example, this may be due to cutbacks or to the changing needs in a company. Advances in technology have eliminated many jobs. Others in this group may be immigrants who are moving into a new culture and learning a new language in hopes of a better life.

Programs for this third group can become an important support in their retraining for a potential career change. Some adults may be hesitant about their ability to learn how to use new educational formats and the new technological modes of delivery. They also may be especially vulnerable to reduced levels of confidence, so restoring confidence becomes a central goal as adult education faculty help such students to shift their thinking to better function within their new vocational realities. Developing or rebuilding confidence in one's communicative ability using recent technological advances is central to 21st century success.

This chapter explores one of the most important transitional challenges confronting many adult learners and their instructors, the need to master new communicative technologies and to use them to write effectively.

Adult Students

Adjusting to New Educational Formats

A significant challenge that many adults confront is how much they can adjust to changing educational formats. Young students who grew up with computers adapt easily to technological advances that are changing the organization and delivery of courses (and potential jobs), but navigating websites and writing email messages and reports can confuse adult students. The reality now is that effective writing has become increasingly important in both courses and future jobs.

Online courses are improving in quality and growing in quantity. However, adult learners who take online courses may unfortunately develop feelings of isolation if they can't easily access adequate support to develop competence in using the new technologies.

Learning How to Write Effectively

Writing is the primary form of communication in many vocational settings. Many adults must learn how to express themselves effectively through writing when completing assignments and participating in online student discussions. This may cause concern for adults who haven't been in school for several years. They may worry about the quality of their writing, especially in technological settings.

Helping students to shift from oral language to written text enhances the shift from being a worker to being a student as they re-enter school. I normally facilitate such transition by asking students to write about their previous work and non-work experiences that relate to class topics. This creates class conversations in which a student's own experience and participation are validated.

I then provide students with questions about other comfortable and familiar issues. They select and write—and then respond to their classmates' written comments during a class conversation about what they wrote. I provide individual feedback on content rather than on grammar. The point in the beginning stages is to develop confidence that what they write is of value.

Students can more easily move into new educational formats by identifying and building on their previous knowledge and skills. Choice in class discussions sparks active participation in learning and a greater chance that student knowledge will be transferred from oral to written form, even if they are initially hesitant to talk about themselves and unsure about their writing abilities. Converting what is known to what is learned is best begun in small steps. Participating in private online communication and progressing into whole class discussion helps students to feel comfortable when beginning online learning. Students can later engage in deeper communication by writing full texts that will get extended feedback and be graded.

Developing Confidence when Returning to School

Adults who consider themselves to be inadequate writers may also be uneasy about their ability to understand and contribute to online virtual course settings. These may include students who are more comfortable in a regular classroom or those who felt more productive in conversational work settings. The difference between face-to-face oral communication and an email-type online conversation is considerable, and it often includes long communication delays.

Adult programs should enhance confidence with new communicative technologies. Providing needed support reduces stressful situations and enhances the confidence that students need to develop their writing skills. My experience in distance education suggests that adult positive reinforcement in learning is best achieved through attending to what students say or write in class settings. One approach is to introduce their ideas into class discussions to illustrate what they're learning in the course.

Inserting student contributions into class discussions also enhances learning by making their ideas relevant and connected to content areas. Similarly, initiating student/teacher dialogue in online courses positively encourages transfer into new formats. Students who note their own weakness in a writing or textual computer format will tend to ask for help rather than struggle through on their own. Instructors must understand that many students need to develop confidence, and so should respond to queries and requests for assistance in a timely and supportive manner.

Adults who have developed a sense of self-confidence tend to ask for help when they need it. This is essential in distance learning programs. Once adults feel accepted and validated in these settings, they are able to more clearly understand the requirements of the jobs they seek, note their own weaknesses, and decide what they still need in order to function successfully in future jobs.

Adult Educators

Many adult education students have had previous difficulty in coping with the traditional educational system. This suggests that adult education faculty need to think very carefully about their own teaching and student interaction techniques. This can help them to identify techniques that are apt to work well with their adult students, and also to be very committed to detecting techniques that are not working.

Many adult educators believe that online teaching is more difficult than traditional teaching because students expect instructors to be available on a twenty-four hour basis. I discovered, however, that a window of one or two days for responding to questions is generally acceptable. A quick response or word of encouragement goes a long way to reduce student anxiety and does not take much time. It also helps to build confidence in the student/teacher relationship.

How to Move into Non-traditional Teaching Modes

Twenty-first century learning must be relevant to context, personalities, and situations. Students who previously had difficulty in school may have found the content and teaching methods irrelevant to their lives back then. They may have rejected the memorize and regurgitate methods of learning, perhaps because they were not particularly good at it and it seemed irrelevant, and also because they didn't expend the energy it required.

The totality of available information is growing very rapidly, and machines are very good at storing and retrieving it. A student's current task is to become more efficient and effective at retrieving information, and to learn to understand, evaluate, and make effective use of information that they retrieve. Students must learn how to sift through somewhat overwhelming amounts of information to identify what is most meaningful for their goals and purposes.

Developing a learner-centered approach to education allows students to explore how different technologies can best be used for specific course purposes and/or to master needed job skills. Centering learning on student needs and interests also allows them to take control of their learning. This strengthens online learning by creating motivational tasks that engage students who aren't working within a traditional classroom.

In order to create active participation, I allow students to experiment with new technologies. As a guide, I try to facilitate independent learning in which they begin to understand how technological tools can contribute to school learning and be applied to future work settings.

As a teacher who tended to work more as a facilitator than as an authoritative figure, I was relieved to discover how online learning could motivate students through their own ideas, goals, and motivations. As a self-directed learner, I recognized how learning is much more meaningful to adults when it is placed into the appropriate contexts of our personal lives, goals, and perspectives.

How to Make Better Use of New Techniques and Technologies

I have found that students benefit from forming groups that are based on individual interest, skill, and life experience categories. Students are able to challenge each other and thereby strengthen their own knowledge. Organizing learning in this way encourages collaboration and meaningful engagement. However, I have also found it quite useful to purposefully violate this approach. A person with little or no job experience can benefit by being in a group of experienced workers who were laid off when their company had to downsize. Such ex-employees are a valuable source of information on what is required to hold a steady job and to "move up the ladder."

I typically establish working groups at the beginning of online courses so that students develop positive relationships and become more comfortable when offering support and feedback for each other. Small group settings work well for adult students because they're more willing to take risks when fewer people are involved. Further, I structure the small group activities so that each member must actively participate. Group members often form close and long-lasting relationships through their discussions.

Discussion/working groups are normally able to function responsibly once they are given specific direction. As group sessions continue, I monitor their interactions and am able to step in to guide or direct their activities when necessary. This process encourages them to develop a sense of independence.

I place strong emphasis on group members by asking them to identify issues with two characteristics:

1. The issues are relevant to both the class topics/objectives and also to the previous experiences of the group.
2. Possible answers can be discovered based on the group's combined experiences.

I thus provide issues for groups to discuss during initial small group discussions. But, as groups become better at group discussion, I insist that they work on developing question-posing skills. In addition, I frequently change the makeup of groups since I don't want a group of "old cronies" to form and then live a sheltered life within their own private group.

How to Support Learners in New Educational Formats

School should ideally help students to develop relationships and communicate effectively within those relationships. In an age of global tolerance, distance educators need to focus on the need for respectful behavior that enhances communication and reinforces congenial relationships. Forging connections through getting to know students on a more personal level establishes trust among students and teachers. This also increases student confidence in a teacher's ability to communicate in ways that enhance their own learning. And, it helps students to develop greater global tolerance.

Educators should encourage learning through open, honest, and clear communication in technology-based learning environments. A sense of respect and tolerance recognizes that students may come from a wide variety of backgrounds, interests, and life experiences. These may influence online communication and the interpretation of meaning in course discussions. Educators must therefore ensure that communication is direct and free of colloquialisms and hidden meanings.

Faculty of online learning courses and their students should be careful about their written responses. I therefore carefully reflect on both my comments to the class as a whole and on how best to provide individual feedback. I hope that my students will do the same, thinking carefully about how they interact with the entire class and with individual students.

Even though I normally act as a guide in the learning process, it's essential for instructors to be assertive in directing learners about appropriate online behavior in order to set the tone for learning. I thus outline how written texts and responses to questions should be made through inquiry and clarification of meaning. To establish trust and good learning relationships, a spirit of collaboration and willingness to accept and learn from one another is necessary in both classroom instruction and in future work settings.

Final Remarks

I enjoy adult education because it gives me the opportunity to directly affect the lives of the students I serve. They have an immediate need for the knowledge and skills that I am helping them develop. At the end of the day, I can go home feeling I have contributed a valuable and long-lasting service to the world.

Chapter 21

IAE Newsletter - Issue 159, April, 2015

Diane Ackerman's Book, *The Human Age: The World Shaped By Us*

Robert Sylwester
Emeritus Professor of Education
University of Oregon

I met Diane Ackerman in 1991 through her book *A Natural History of the Senses*, and I was instantly smitten. She's a superb natural sciences essayist who describes in *The Human Age: The World Shaped By Us* (2014), her most recent of many books, how our body/brain systems take in and understand our planet. She further warns of the dangers of not wisely caring for it.

She obviously isn't the first to eloquently raise an alarm. Rachel Carson did it with *Silent Spring* in 1962, focusing on the effects of insecticides and pesticides on songbirds. In her newest book, *The Human Age: The World Shaped by Us*, Ackerman pretty much focuses on everything our progeny will eventually ask us to explain. And that's a bundle.

Welcome to the Anthropocene Era

The earth's environmental history is divided into ages based on which organism dominated (e.g., Cenozoic = post-dinosaur). Humans are currently the dominant species in the world, so Anthropocene Era is now used for our current era. The human population has grown rapidly in recent years, quadrupling during the past 150 years to over seven billion. This despite the suggestion of the renowned biologist E.O. Wilson that the growth of organisms during the 20th century was more bacterial than primate.

Our technological tinkering has given the earth a low grade CO2 fever that we need to attend to before it gets far enough out-of-hand to destroy us and other creatures on earth. The earth doesn't need us since it existed billions of years before we arrived, and it could continue long after us. The future shards of our existence might well remain as geological layers of plastic and metal.

Humans are resourceful, as recent advances in science and technology demonstrate. Ackerman describes several intriguing proposals, such as shifting a lot of farming from land to ocean. The issue isn't how to protect the ocean and marine life, but rather how we can correctly use the ocean to help support us. She suggests three-dimensional ocean farming as an intriguing concept (http://www.thimbleislandoysters.com/1379-2/). Although many people aren't used to eating kelp, we've adapted our diet many times over many millennia (http://www.takepart.com/article/2013/09/18/its-safe-eat-kelp).

More than half of the world's population (and 90% in Argentina) now lives in cities. Ackerman suggests that we should begin to focus on what's called Reconciliation Ecology, the co-existence of humans with nature, inserting plant and animal life wherever possible within dense urban areas. We should consider replacing manicured lawns with small gardens, sod roofs, rooftop gardens and hydroponics—and perhaps moving chickens, rabbits, and pollinating bees from farm to city.

Buildings could become living organisms, producing as much or more energy than they use. For example, imaginative Zimbabwe architects now use procedures that are similar to what termites developed over many millennia to regulate the temperature in their towers. With limited sunlight the Swedes have become leading innovators with solar energy. Add wind power, recycling of wastewater, getting energy from burnt garbage, updating building codes, and other innovations and they've reduced their oil dependency by 90%, trimmed CO2 by 9%, and reduced sulfur pollution to pre-WWI levels.

Burning coal, oil, and wood as fuel is like burning sunlight. The shift now should be to use other properties of sunlight.

Nature as Natural

What's natural? Plants and animals have adapted to the environment that we've developed. For example, urban blackbirds become active earlier in the day than rural blackbirds. The urban animals in several species that were studied have larger brains than their rural counterparts. Successful animals are those that can best tune to the available environment, and for some that's the complex urban environment in which humans predominate. My neighbor's cat comes over to our house every day at about the time we eat, and we usually give her something. We recently discovered that she also goes to another neighbor an hour later when they eat. How does the cat know when the two of us will eat? If you're an urban cat, what else do you have to remember?

We've now created a hybrid environment in which our needs/wishes rather than natural forces determine the environment. We transport plants and animals from one environment in which they fit into another environment in which they become invasive since the new environment lacks their former regulatory controls. A single predator inappropriately introduced into an environment can eliminate or change many species. We've further affected our environment through an oil and coal-based dependence that's changing our climate. For example, about half of the 305 North American bird species now winter an average of 35 miles farther north than they did 40 years ago. Arctic ice is melting, some parts of the U.S. now have several inches of rain in a few hours, and the Southwest is experiencing a severe drought. Our climate is changing.

What should we do about this problem in a democratic society in which individuals and groups have opportunities to present their often biased perspectives? For example, Ackerman reports that a foundation is currently freezing reproductive cells and eggs of species facing extinction, and using DNA analysis to possibly restore Mammoths who died in eras in which its DNA froze. That may seem laudable, but do we really want to restore plants and animals at some later date, after their preferred habitat no longer exists?

Most Americans say that they favor conservation, but does that mean that we want well-tended, visitor-friendly national parks; hiking-friendly Appalachian or Pacific Crest Trails that extend for thousands of miles; or huge wilderness areas that discourage visitors and prohibit logging, grazing, or farming?

Moving Beyond Nature

Our tool-making capabilities are moving us indoors, away from the nature we formerly experienced. As a ten-year-old put it, "I like to play indoors because that's where the electrical outlets are." Nearsightedness has increased because young peoples' visual focus today is more tuned to a nearby screen than to the wider outdoors. The novelty and convenience of our increasing digital environment is replacing our biological environment, now typically experienced via screened reality or animation.

We now have two selves, our physical self that emerged over many millennia and our virtual online self that's present even when we're absent—a self we constantly maintain so that people can contact us when we're not available in person, a self that allows us to interact with what's going on anywhere while we remain here. Interactive computers emerged about 50 years ago. Further, within the past few years, interactive social systems have revolutionized society and many of its institutions.

Advanced robots are probably next on the technological agenda. The development of artificial life will follow artificial intelligence. It's already well on its way from science fiction to technological reality. Some are concerned that we won't be able to control robotic behavior, seemingly forgetting that we also can't control human behavior. If robots take over much of the work that formerly occupied human life, will that free us up to become a different kind of humanity that's not dominated by physical work?

The 3D printing revolution has moved beyond simple printing towards object construction. 3D printers are in their beginning stages and the 3D printing of some human body part replacements is now occurring.

Humans have long incorporated false teeth, hearing aids, artificial hips, and contact lenses into their bodies. I have a cow aortic valve to replace my own failing heart valve. Should we also think of clothing and shoes as early human skin prosthetics? Wars are terrible, but they tend to enhance the development of technology.

At the atomic level, we're living beings who are composed of nonliving parts. In addition, 90% of a human body is composed of bacteria, viruses, archaea, and fungi. Only 10% of the cells in our body are actually human. We share our human ecosystem with 10,000 species of microorganisms. We're thus not lone, autonomous individuals but are perhaps a bit of us and a consortium of microorganisms (that can often outvote us).

Ackerman concludes her exploration of our planetary era with the suggestion that we are an altogether different kind of animal than any the planet has known before. We've been able to reinvent the world to fit our wishes. We've survived, despite facing more challenges than any other animal. We currently inhabit a much more complex mental challenge than did our ancestors.

Her challenge is simple: Don't blow it with an over-riding sense of self-importance.

Beyond Ackerman: Emerging Educational Challenges

What challenges confront educators? Some might suggest that the next generation has more than enough issues to solve, or at least to begin a search for solutions. To work effectively in finding solutions, young people will need to experience a very different kind of education from what is now being offered. The informal and formal education they receive should help prepare them to become responsible adults who can work with other adults to address global problems. Reading, writing, and arithmetic are all important parts of schooling. However, understanding global sustainability and how our quality of life depends on it can and should be thoroughly integrated into our schooling system.

Futurists such as Rachel Carlson and Diane Ackerman are basically educators who need to reach the huge audience of the earth's population. Such visionaries can inspire us, but they'll need the entire educational system to take a strong leadership role.

A top-down approach works at the world, national, and state levels. A bottom-up approach works at the school, community, and city grassroots levels. The hundred-year-old expression "think globally, act locally" captures the essence of using both top down and bottom-up approaches.

If you want to go back still further in time, remember Benjamin Franklin's statement at the signing of the Declaration of Independence, "We must, indeed, all hang together, or assuredly we shall all hang separately."

References

Ackerman, D. (2014). *The human age: The world shaped by us.* New York: Norton.

Ackerman, D. (1990). *A natural history of the senses.* New York: Vintage.

Carson, R. (1962). *Silent spring.* New York: Houghton Mifflin.

Chapter 22

IAE Newsletter - Issue 156, February, 2015

The Future through Quotations

David Moursund
Professor Emeritus of Education
University of Oregon

> "We may not be able to prepare the future for our children, but we can at least prepare our children for the future." (Franklin D. Roosevelt; 32nd President of the United States; 1882-1945.)
>
> "The purpose of education, finally, is to create in a person the ability to look at the world for him/herself." (James Baldwin; American novelist, playwright, and civil rights activist; 1924-1987.)
>
> "Human history becomes, more and more, a race between education and catastrophe." (H.G. Wells; English science fiction author; 1866-1946.)

The quote from Franklin D. Roosevelt captures two important ideas:

1. Our world is changing and we do not have as much control over these changes as we might like. Think about the time of Roosevelt's Presidency. He began his Presidency in 1932, near the height of the U.S.'s Great Depression. He died in office in 1945, near the end of WWII. There were huge changes in the world during that time.
2. We should provide our children with an education that prepares them for change—that provides them with the flexibility and capabilities to deal with unforeseen events and circumstances. The pace of change in our world increased rapidly during the Industrial Age that began about 250 years ago, and still more rapidly since the Information Age began in 1956.

To me, these two ideas suggest that we should do our best to make accurate forecasts of what will come from the rapid changes in our world that have been going on and show no signs of slowing. Our educational system should help prepare students for these types of changes, but also give them knowledge, skills, and flexible habits of mind that can help them to adjust to unforeseen changes. We know, for example, the number of well-paying middle class jobs is declining and that an increasing number of jobs are being done by robots and/or being outsourced to other countries.

Quotations

For many years I have been collecting quotations that resonate with my own views (Moursund, 2015). Each conveys a message that seems important to me. Each quote is from the past, and each is designed to pass on insights and wisdom to the future. As I read from my collection of quotations, I am always amazed by how smart their authors were!

I think of each quotation in my collection as a very short story and I often make use of the quotations in my writing. This final newsletter in the Education for Students' Futures series consists of some future-oriented quotations from my collection. For each, I provide a short commentary that represents some of my beliefs about the future of education. The paragraphs after the Roosevelt quotation given above provide an example that I replicate several times in the remainder of this newsletter.

Rights of the Child

> "Mankind owes to the child the best it has to give." (United Nations Declaration of the Rights of the Child, 1959.)
>
> "Education must be increasingly concerned about the fullest development of all children and youth, and it will be the responsibility of the school to seek learning conditions that enable each individual to reach the highest level of learning possible for her or him." (Benjamin S. Bloom; American educational psychologist; 1913-1999.) Also see http://chapters.rowmaneducation.com/15/788/1578862434ch1.pdf.
>
> "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.)

I believe that our current educational system and most of the on-going attempts to reform it are backward looking rather than forward looking. They focus on improving and doing better most of the same things we have been doing in the past. They do not focus on how the world has changed and the very rapid changes that continue to occur.

As I have pointed out in chapters 14 and 15, the future will provide all students with teaching machines that can access much of the collected knowledge of the human race and provide high-quality interactive (just in time, when this is appropriate) instruction. We can prepare students for this future by giving them instruction and practice in learning in this new environment. In this type of instruction, students learn to pose researchable questions, search for and then select credible and valid answers, and understand and use the information they are retrieving.

What People Do Better than Computers

> "The ability to deal with people is as purchasable a commodity as sugar or coffee and I will pay more for that ability than for any other under the sun." (John D. Rockefeller; American industrialist and philanthropist; 1839-1937.)
>
> "The Gross National Product does not include the beauty of our poetry or the intelligence of our public debate. It measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion. It measures everything, in short, except that which makes life worthwhile." (Robert F. Kennedy; American statesman; 1925-1968.)

Education is a human endeavor. It is far more than preparing students to score well on a state, national, or international test. Indeed, I believe that our current emphasis on high-stakes tests is seriously damaging our educational system.

Education has many generally accepted goals. For one example, see the Appendix: Goals for Education in the United States in *Common Core States Standards for K-12 Education in America* (Moursund & Sylwester, 2013). All 14 goals listed there are more "lofty" than scoring well on a few high-stakes tests. For example, compare *learning to learn and becoming an independent, self-sufficient lifelong learner* with *scoring well on high stakes tests*.

The success of IBM's Watson computer in the TV game of Jeopardy suggests that we can now build computer systems that can outscore students on these types of tests (Moursund, 2/9/2011). Of course, that would be a silly use of research and development dollars. Since its success in Jeopardy, IBM has been investing heavily in developing computer systems that can work with humans in helping to solve medical and business problems (Moursund, 9/23/2012). A future-looking educational system will prepare students to work effectively with such computer capabilities rather than trying to learn to compete against them.

The basic issue is that humans can do many things better than computers, computers can do many things better than humans, and the two working together can perform better than either alone. Therein lies the future of education.

Learning by Being Involved and Doing

> "I hear and I forget. I see and I remember. I do and I understand." (Confucius; Chinese thinker and social philosopher; 551 BC-479 BC.)
>
> "We discovered that education is not something which the teacher does, but that it is a natural process which develops spontaneously in the human being. It is not acquired by listening to words, but in virtue of experiences in which the child acts on his environment. The teacher's task is not to talk, but to prepare and arrange a series of motives for cultural activity in a special environment made for the child." (Maria Montessori; Italian physician, educator, philosopher, and humanitarian; 1870-1952.)
>
> "People rarely succeed unless they have fun in what they are doing." (Dale Carnegie; American writer and lecturer; 1888-1955.)
>
> "Nothing could be more absurd than an experiment in which computers are placed in a classroom where nothing else is changed." (Seymour Papert; South African/American mathematician, computer scientist, and educator; 1928-.)

I like to ask children, "What did you learn in school today?" and "What did you do in school today that was fun?" I am bothered by how often I hear answers suggesting school is boring, school is not fun, and similar disparaging remarks. When students tell me something that they studied that day, I ask the student to teach me some of what they learned. I often detect little enthusiasm or interest in the topic on the part of the student. I am reminded of the Dale Carnegie quote given above.

We know that people learn by doing things that are of interest to them. Some of what we teach in school immediately empowers students and is inherently (intrinsically) interesting and applicable in the "here and now" of a student's life. Much is not.

Thus, it is not surprising that many students would rather engage in computer-based or face-to-face social networking, browse the Web, play computer games, or carry on other activities that provide active engagement and are more interesting and fun than what the teacher is saying and doing.

For myself, I find learning to be both fun and hard work. How can we design our educational system to be sufficiently fun and intrinsically motivating so that it will challenge students to overcome the obstacle of the necessary continuing hard work? We see this occurring in competitive sports, music and dance, and many other learning situations in which students choose to participate and seek to improve their knowledge and skills.

I am reminded of a College of Education Dean whom I met a number of years ago. His doctorate was in Music Education. When he was in the sixth grade he convinced his principal (who was also the school district superintendent) that he should be allowed to drop his math class in order to provide more time for studying and practicing music. At that time in his life, music seemed much more important than math. (I presume he eventually took more math or learned it on his own, as being a Dean certainly requires more than elementary school math.)

Final Remarks

> "Knowledge is of two kinds. We know a subject ourselves, or we know where we can find information upon it." (Samuel Johnson; British author and father of the English dictionary; 1709-1784.)

If Samuel Johnson were alive today, he would likely add to his statement:

> Skills also are of two kinds. We know a skill ourselves, or we can learn to do it and to use the requisite tools humans have developed.

Johnson might also note we know how to earn money to hire someone to do the things that we know need to be done, things that we do not have the knowledge, skill, time, or inclination to do them ourselves.

I think the following quote reaches far back in our history to provide a suitable ending to this book:

> "The secret of change is to focus all of your energy, not on fighting the old, but on building the new." (Socrates; Greek philosopher; circa 469 BCE-399 BCE.)

References

Moursund, D. (2015). Quotations collected by David Moursund. *IAE-pedia*. Retrieved 1/29/2015 from http://iae-pedia.org/Quotations_Collected_by_David_Moursund.

Moursund, D. (9/23/2012). The future of IBM's Watson computer system. *IAE Blog*. Retrieved 1/29/2015 from http://i-a-e.org/iae-blog/entry/the-future-of-ibm-s-watson-computer-system.html.

Moursund, D. (2/9/2011). Game of Jeopardy: Computer versus humans. *IAE Blog*. Retrieved 1/29/2015 from http://i-a-e.org/iae-blog/entry/game-of-jeopardy-computer-versus-humans.html.

Moursund, D., & Sylwester, R., eds. (2013). *Common core states standards for K-12 education in America*. Eugene, OR: Information Age Education. Available for free downloads: Microsoft Word file from http://i-a-e.org/downloads/doc_download/249-common-core-state-standards-for-k-12-education-in-america.html. PDF file from http://i-a-e.org/downloads/doc_download/249-common-core-state-standards-for-k-12-education-in-america.html.