

Forget the Harvard Comma and the Fibonacci sequence: What Do Kids HAVE to Know to Be Prepared for Their Futures?

Do you remember the Harvard Comma, also known as the Oxford Comma, from your classroom days? How about the Fibonacci Sequence -- have you used that information from a long ago math class? Perhaps you have if your work involves planning algorithms or writing computer code. How do we know what we will need to know to be successful in life and in the work place? And how does that relate to how we educate today's students who are the workforce of tomorrow? How do we define a twenty-first century education? This paper will take a look at those issues.

In looking at our recent past, "between 2002 and 2007, cell phones displaced landline telephones as the technology Americans said would be hardest for them to give up. Not only that, in just half a decade cell phones and the Internet both unseated the second most indispensable technology in 2002 – the television. The numbers signaled an abrupt change not just in how but *where* people are accessing information: An astonishing 62 percent of Americans said they use mobile technology to access digital data and tools "on the go" outside of their homes and workplaces.

Of course, technology has been transforming human life in one way or another for thousands of years. The mechanization of agriculture transformed the American labor market in the first half of the 20th century. But in the computer age, the pace of technological change is very rapid. And when essential daily tools can change in just five years, the impact over longer stretches of time can be profound. Many experts say that since the 1970s, new technologies, combined with demographic, political, and economic trends, have altered Americans' work and social lives in ways that have significant consequences for today's young people.

Those trends have prompted some education reformers to argue that the traditional curriculum is not enough: schools must provide students with a broader set of “21st century skills” to thrive in a rapidly evolving, technology-saturated world. But defining what that term actually means can be daunting. As the author of a recent report lamented, “For all of the talk about 21 century skills, trying to figure out what they really are is not easy. The term is everywhere and used to describe pretty much every imaginable skill or attribute: soft skills, life skills, key skills, interpersonal skills, workforce skills, non-cognitive skills ...the list of skills goes on and on.” One framework lists 22 separate sub-skills deemed necessary to succeed in the 21st century!”(Jerald, 1)

A central question is, how is the world changing in ways that impact skill demands? “While it is difficult to peer into to the future to ascertain what skills will be important 30 years from now, it is possible to examine trends that have changed the demands of work and life in the recent past and continue to do so today. The most important are automation, globalization, workplace change, and policies promoting increasing personal responsibility.

Anybody who has recently visited a factory understands that the impact of automation—the use of computers and computer-driven machinery to replace human labor—has been significant. But automation means more than just replacing humans with computerized machinery on assembly lines. Today, computers are increasingly able to accomplish a wide range of work-related *thinking* tasks once performed by humans. Labor market economists Richard Murnane of Harvard University and Frank Levy of MIT have documented how computerization is increasing the demand for some kinds of skills even as it erases many jobs that once paid good wages. They say that across the economy, while computers are not yet “doing all of the work,” they are increasingly doing most of the *routine* work.

That is because computers are good at information processing, and *every* job requires information processing of some sort. “The financial analyst who reads numbers in a spreadsheet, the farmer who looks to the sky for signs of rain, the chef who tastes a sauce, all of these workers are processing information to decide what to do next or to update their picture of the world,” Levy and Murnane point out.

Computers can perform a task if the information involved can be digitized and presented in a suitable form—one that the computer can understand and process. And computers are particularly good at information processing tasks that require following a set of prescribed rules. In fact, any job where information can be digitized and key tasks can be broken down into a set of predictable rules is vulnerable to automation. And because it is cheaper to use computers to follow directions than to pay humans to do so, those jobs are rapidly disappearing. The jobs that are most vulnerable are those in manufacturing and administrative support—work that used to pay good wages for supporting a family.

But automation has also begun to replace humans in some kinds of more sophisticated “white collar work.” For example, computer programs like Turbo Tax have taken jobs away from accountants. According to the report of the New Commission on the Skills of the American Workforce, “It turns out that in the past many middle managers were paid for collecting data, analyzing them in fairly routine ways, and passing the results up to senior management. Not anymore. If work is routine, no matter how complex it is, chances are it can be automated.”

(Jerald, 2)

At the same time, there remain many tasks that computers cannot perform, and those tasks are becoming more important in today's economy. Think about the automated ticketing kiosks in every airport. If they are so easy to use, why are so many travelers still standing in line to speak with a human ticketing agent? Of course, some travelers simply might not like dealing with computers. But in many cases it is because travelers have some kind of special problem or question the computer has not been programmed to handle.

“Levy and Murnane call such tasks “**non-routine**” because they cannot be broken down into a set of predictable rules or simple kinds of pattern recognition. Their research shows that **two** kinds of non-routines skills are increasingly important. The first is “expert thinking,” the ability to solve unexpected problems for which there are no predictable and programmable rule-based solutions. The second is “complex communication,” which involves interacting with other people to acquire information, to explain it, or to persuade others of its importance. Those skills are not superseding traditional skills in reading, writing, and math but rather increasing the demand for “the three R’s,” since basic skills provide a solid foundation for expert thinking and complex communication.” (Jerald, 3)

Recent research has shown that skill demands are changing significantly within occupations. “Examples of “up-skilling” are abundant not just in white collar jobs but also among the so-called blue collar trades that continue to pay good wages. For example, on its website, the Electrical Training Institute of Southern California warns prospective apprentices: “Don’t be influenced by those who see the electrical construction trade as an occupation requiring only a strong back and a weak mind. The electrical trades are becoming more technical each day.” The International Brotherhood of Electrical Workers has developed a screening test that asks

applicants for apprenticeships to solve algebra problems and answer reading comprehension questions, as do many online employment applications.

Economists predict that as technology continues to advance, computers will be programmed to tackle tasks that are currently performed by humans. However, since it is difficult to anticipate specific advances in computer programming, it is extremely difficult to predict precisely which kinds of jobs will be at most risk in 30 or 40 years. Back in 2007, at a workshop on future skill demands, economist Stuart Elliott presented the results of a pilot study predicting that, based on current cutting edge research in artificial intelligence, by 2030 computers could substitute for human abilities in occupations that currently employ *60 percent* of the national workforce.”

(Jerald, 6) At the time it was noted, that how seriously one should take those predications was debatable, as making such long-term predictions requires too many assumptions. “Even if his prediction is true, new jobs are also being created at the same time as a result of advances in technology.” (Jerald, 6)

For now, we know that computers are becoming very good at performing any kind of work that mainly involves following directions—even relatively complex tasks that involve decisions based on many possible “if then” scenarios. If the scenarios can be predicted, the task can be programmed. Therefore, any school curriculum that emphasizes following direction to find a single correct answer is, by definition, preparing students for jobs that will not exist by the time those students graduate. That does not mean that following directions is not an important skill, but rather that it is no longer a sufficient skill for earning a middle-class wage. As Levy and Murnane put it, educating students to compete with a computer is to educate them for a competition they cannot win.” (Jerald, 6)

Economists now have access to several decades' worth of educational and economic data, they are able to analyze the relationship between a nation's skills and its economic prosperity in sophisticated ways. Several recent studies found that cognitive skills as measured by international assessments of math, science, and reading are powerful predictors not only of individual earnings but also the distribution of income in a society and long-term economic growth at the national level.

“Unfortunately, compared with their peers in other industrialized nations, U.S. teenagers achieve largely mediocre results on international assessments that look at the kind of problem-solving skills Levy and Murnane describe. On the 2006 Program for International Student Assessment, which assesses students' ability to apply their knowledge to solve unfamiliar problems, Americas' 15-year olds ranked below the international average in both math and science literacy among 30 industrialized nations. Three years earlier, American 15-year olds ranked at the international average in reading literacy and below the average in problem solving among 29 developed countries.

Moreover, the Skills Commission report argued that, for the U.S. to maintain its global competitiveness, it will not be enough for America to ensure students are merely competent in traditional school subjects. Other countries will have workers who excel in those subjects and who are willing to work for lower wages. According to the Commission, Americans will have to offer something else, they believe that the only reason the rest of the world will be willing to pay us twice as much as other equally competent people is if we add creativity and innovation on a grand scale to sheer competence, not just among elite managers but for virtually everyone in the labor force.” (Jerald, 9) Globalization is also affecting the types of knowledge and skills students will need to thrive. Since they will be collaborating with people around the world, they

will need to have greater “global literacy” – knowledge about people and cultures outside the U.S.

What about workplace change? What are the implications for educating the workers of the future? “Corporations have changed dramatically in the last twenty years in terms of the ways that work is organized, says Karen Bruett, manager of strategic business development in K-12 education at Dell Computer Corporation. According to Bruett, most companies used to have big hierarchies, and were very top-down in their management styles, and employees were very specialized in their functions. However, if you look at what’s going on in any company today, the organization has been flattened. In response to technological change, globalization, and other competitive forces, American companies have radically restructured how work takes place and how jobs are defined and performed. Part of the transformation has to do with the transition to a knowledge and service economy.” (Jerald, 11)

Many companies have realized that in a global knowledge economy, human capital is their most important resource. And they are using their human capital in very different ways than they did 30 years ago. Especially in globally competitive firms, jobs have changed in a number of key ways: there is less hierarchy and supervision, and more autonomy and responsibility as seen with the rise of self-managed work teams, coupled with more collaboration of cross-functional teams working together on projects, which creates less predictability and stability in the workplace for the individual worker. The traditional concept of a job is changing. In many companies, formal and static job descriptions are no longer an essential management strategy. Instead, companies often use more flexible work assignment descriptions, such as the title of the project the employee is working on.

Clearly, workplace and corporate change is having a large impact on skill demands. “To succeed in flat organizations characterized by less supervision and greater individual autonomy, individuals need to be able to act independently to identify opportunities and solve problems on their own. They will also need strong interpersonal skills – written, oral, and social – to collaborate effectively with colleagues on self-managed work teams, regardless of where the team is located – whether they are down the hall or virtually connected to a far-flung global team. They will need to know how to acquire the information they need to do a job, and they will need to be able to learn new skills as corporations change strategies to stay competitive.” (Jerald, 15)

Corporations are also requiring their employees become more responsible for their financial security in their retirement by offering defined contribution plans such as IRA’s rather than a corporate pension; as well as assuming more responsibility for their health care costs. “Taken together, all of these workplace trends have created twin forces that are changing what it takes to thrive in the adult world: First, the environment that people live in is becoming more complex and demanding, while second, individuals are being asked to take on greater responsibility in their work and personal lives.

“Students will need strong skills to navigate a world where personal choices are fraught with greater risk. At the very least, they will need strong math and reading skills to understand the information necessary to understand their options. And they will need to be able to use what they learn in school to understand critical information – including health and financial information – in order to make sound decisions that ensure their well-being.” (Jerald, 20)

In light of the information from the economist about the skills needed in the workplace, what are the implications for educators, policymakers and students themselves? The past two decades have seen the emergence of a global movement that calls for a new model of learning for the twenty-first century. There is a significant body of knowledge on the competencies and skills needed to function effectively in the twenty-first century, but there is *no* single proscribed approach to educating young people to equip them with the skills identified as necessary for the workplace. Herein lies the challenge to making sense of all of the data from the educators.

In *The Futures of Learning 2: what kind of learning for the 21st century* Cynthia Luna Scott writes “that over the last two decades, no fewer than ten international organizations and commissions, governments, private consortia and private institutions have proposed frameworks and outlined competencies needed to address twenty-first century challenges that students will need to master. In 1996, the International Commission on Education for the Twenty-first Century released the *Delors Report* which included one of the first frameworks to identify competencies needed in the coming century that other educational theorist have built upon. The *Delors Report* also formulated four principles identified as the Four Pillars of Education: Learning to Know, Learning to Do, Learning to Be and Learning to Live Together.” (Scott, 2) This framework is relevant today and can be expanded and redefined. This paper will use the Delors Pillars of Education to provide an overarching organizational framework to look at the array of competencies put forth by various researches and educators as necessary for the twenty-first century learner.

One of the challenges is that for the most part curriculum development worldwide has not kept pace with current expectations about learner competencies and skills or new tools to support learning as related to future workplace expectations. There are a number of effective, researched

based curriculum models guiding twenty-first century learning. I will attempt to highlight a few of the proposed curriculum models.

“In 2006, Sternberg and Subotnik argue for a curriculum focused on fostering learners capabilities in what they identify as ‘The other 3R’s’: *Reasoning, Resilience and Responsibility*. *Reasoning* is defined as analytical, critical thinking and problem-solving skills; *Resilience*, is defined as life-skills such as flexibility, adaptability and self-reliance; and *Responsibility*, is defined as wisdom or the application of intelligence, creativity and knowledge for a common good.

However, in 2010, Tony Wagner and the Change Leadership Group at Harvard identified another set of competencies and skills. Informed by several hundred interviews with business, non-profit, and education leaders, Wagner stressed that students need seven survival skills to be prepared for twenty-first century life, work and citizenship, they are:

- Critical thinking and problem solving;
- Collaboration and leadership;
- Agility and adaptability;
- Initiative and entrepreneurialism;
- Effective oral and written communication;
- Assessing and analyzing information;
- Curiosity and imagination.

Wagner and his team advocate a curriculum based on very different principles which they term as ‘The new 3 Rs’: *Rigour, Relevance and Respect*. *Rigour* refers to the abilities and capacities students acquire as a result of their learning. *Relevance* refers to their understanding of how their

learning connects to current real-world challenges and future work. *Respect* refers to the promotion of respectful relationships among teachers and students that foster academic and social competence.

While, in 2007 David Conley, another educator, emphasizes the importance of learners developing what he terms as ‘habits of the mind’ including analysis, interpretation, precision and accuracy, problem-solving, and reasoning to support thinking and reflection. And, in 2012 Prensky advocates a student-centric curriculum founded on ‘The 3 Ps’; these consist of *Passion*, including character; *Problem Solving*, including communication; and *Producing* that which is required with creativity and skill.

However, the Assessment and Teaching of 21st Century Skills project categorized twenty-first century skills internationally into four broad categories – ways of thinking, ways of working, tools for working, and skills for living in the world. Meanwhile, the U.S. based Apollo Education Group, a provider of higher education programs for working adults, cited the ten skills needed by students to survive as twenty-first century workers as: critical thinking, communication, leadership, collaboration, adaptability, productivity and accountability, innovation, global citizenship, entrepreneurialism, and the ability to access, analyze and synthesize information.

Lastly, the U.S. based Partnership for 21st Century Skills (here after I’ll refer to as P21), a collection of business leaders and educators, proposed a Framework for 21st Century Learning, which identified essential competencies and skills vital for success in twenty-first century work and life. These included ‘The 4Cs’ – communication, collaboration, critical thinking and creativity, which are to be taught within the context of core subject areas and twenty-first century themes. This framework is based on the assertion that twenty-first century challenges will

demand a broad skill set emphasizing core subject skills, social and cross-cultural skills, proficiency in languages other than English, and an understanding of the economic and political forces that affect societies.” (Scott, 3)

In looking at these potential competencies and skills in greater detail, they can be organized into the *Four Pillars of Education* outlined in the Delors Report.

The first pillar, *Learning to Know*: among the educational theorist there is general agreement that mastery of core subjects and learning around twenty-first century themes are essential for today’s students. Core subjects include: grammar, reading or language arts, world languages, art, mathematics, economics, science, geography, history, as well as government and civics. There is also general agreement that twenty-first century learners must commit themselves to lifelong learning; they must continually assess what they know and still need to discover and understand for success in work and life. They must be ready to retrain themselves when new situations require new skills.

Education theorists are also consistent in saying that schools must weave twenty-first century interdisciplinary themes into core subjects. There are four themes with relevance for modern life: global awareness; civic literacy; health literacy; and financial, economic, business and entrepreneurial literacy. In recent years professional education groups have advocated introducing these themes into the curriculum to better prepare students for the demands of adult life and work. In this, there is much alignment of what the economist also identify as necessary skills for the future workforce.

The second pillar, *Learning to Do*: the skills in this category stress active learning. The first skill is critical thinking which is considered fundamental to twenty-first century learning and vital to workplace success. Critical thinking involves accessing, analyzing and synthesizing information, and can be taught, practiced and mastered. Critical thinking also draws on other skills such as communication, information literacy and the ability to examine, analyze, interpret and evaluate evidence. Today's citizens need to be able to compare evidence, evaluate competing proposals and make responsible decisions.

Problem solving is another basic skill in this rubric. Problem solving requires individuals to draw from multiple domains to find solutions to complex issues. Problem solving generally involves teamwork and cooperation. Successful problem solving requires effective and creative collaboration between learners, who must keep pace with evolving technology and often handle vast amounts of often contradictory information. In order to resolve a problem it is important to define it and understand its elements. It is also necessary to identify the resources and strategies needed to solve the problem. Critical thinking skills are fundamental to this process. Flexibility and self-direction are also critical to problem solving, and success often depends on knowing when and how to access the expertise of others.

Which brings us to communication and collaboration. Strong communication abilities including the capacity to express thoughts clearly and persuasively both orally and in writing, articulate opinions, communicate coherent instructions and motivate others through speech, are highly valued in the workplace and in public life, according to the National Education Association. Collaboration and teamwork are developed in schools and by out of school experiences. Students learn together as they work collaboratively on project-based assignments and develop skills by teaching their peers in groups.

Creativity and innovation can also be categorized as part of learning to do. The capacity to innovate and demonstrate a creative spirit are becoming requirements for personal and professional success, and lead to developing an entrepreneurial mindset. According to the Center for Curriculum Redesign, divergent thinking and enthusiastic experimentation boost creativity and innovation.

Also included under the banner of “Learning to Do” is Information, Media and Technology Literacy. This literacy is described as the ability to access, evaluate and use information. This is a skill set that is ever so topical in light of headlines of the day related to the reliability of the news, and sources of the news. Odd, but true, there are many people who consider Facebook an authoritative source for news and information. Clearly, there is more work to be done in developing this literacy regardless of where you are on the formal or informal education continuum.

Information, Media and Technology Literacy is; however, seen as separate from Information, Communication and Technology Literacy, also known as ICT. Being ICT literate means possessing the ability to easily access, manage, integrate, evaluate and create information through the use of digital communication and technologies. Some might say that in light of the recent 37 page indictment of 13 Russians in a scheme to incite political discord in the United States, they exhibited a very sophisticated understanding of the use of ICT skills.

The third pillar from the Delors report, *Learning to Be*: encompasses a significant body of knowledge on preparing youth for life in the twenty-first century. Just as cognitive competencies are fundamental so are the personal qualities that shape learners’ identities, guide their responses

to failure, conflict and crisis, and prepare them to tackle the difficult life problems they will face. According to the P21 framework, young people need to be able to work with and learn from diverse groups in a variety of work and social settings, and be able to adapt to changing times. Good social and cross cultural skills are crucial to successful functioning both in schools and in life. These skills allow individuals to interact effectively with others, such as knowing when to listen and when to speak, how to work effectively in diverse teams, how to respect cultural differences, how to be open-minded to collaborating with people from a wide range of social and cultural backgrounds, and to use social and cultural differences to generate ideas, innovation and better quality work. Good social skills can help learners make good choices.

Personal responsibility, self-regulation and initiative is heightened by the increasing level of interaction and teamwork expected in the twenty-first century workplace. The ability to self-govern is at the heart of twenty-first century learning. Self-directed learners take personal responsibility for their learning and are willing to improve their capabilities throughout their careers. In 2012, the Association for Talent Development identified adaptability, or the capacity to change in response to shifting conditions in the economy and marketplace and quickly master new skills, as one of the top three competencies required in the twenty-first century workforce. P21 has also identified self-directed learning as a necessary life and career skill. Developing an entrepreneurial mindset and thinking skill, which can be seen as the ability to recognize and act on opportunities and the willingness to embrace risk and responsibility, enables individuals to create jobs for themselves and others according to P21. Because of this it will be important to teach learners to think on their feet. Creating the habit of lifelong learning will be crucial in ones' ability to adapt to a changing workplace.

The last pillar, Learning to Live Together, encompasses the competencies related to living and working together in culturally diverse societies and organizations. It involves respecting and valuing the concerns of other people and cultures different from ones' own and acquiring the cross-cultural skills to seek out the views of others. It also involves building awareness of and appreciation for differences among individual and communities.

Another competency that can live under this pillar is civic literacy. Civic literacy has been deemed an essential skill by P21 and consists of knowing how to exercise the rights and obligations of citizenship at local, state and national levels; as well as developing the motivation, disposition and skills for civic participation. And understanding the local and global implications for civic issues. P21 also posits that another vital skill is digital citizenship which they define as knowing how to participate productively and responsibly online. That it is essential to help students understand how to participate intelligently and ethically as responsible citizens in virtual communities. In their view, this involves learning how to assess the reliability and quality of information found on the internet and using information gained in a responsible manner.

As you can see there is an amazing overlap of similar concepts but no single approach or agreed upon set of definitions by the educational theorists.

So what does it all mean? In *Defining a Twenty-First Century Education*, Craig D. Jerald states that a solid education today demands not only a strong foundation or 'core', in content knowledge -- fundamental academic knowledge -- but also literacy or the ability to apply it to the real world, and both are essential to develop broader competencies like critical thinking and problem solving. Regardless of which multitude of competencies you identify with from the education theorist, it is clear that there is alignment in the skills that economist have identified as

necessary and the skills educators deem critical for today's learners. How to integrate and assess mastery of these skills is perhaps the topic of another Quest paper.

Circling back to where we began with the Harvard comma it is interesting to note the headline of a recent New York Times article, "Suit Over Oxford Comma Is Settled, for \$5 Million and a Slew of Semicolons....the article goes on to say that the Oakhurst Dairy settled an overtime dispute with its drivers that hinged entirely on the lack of an Oxford comma in state law. The relatively small-scale dispute gained international notoriety last year when the United State Court of Appeals for the First Circuit ruled that the missing comma created enough uncertainty to side with the drivers, granting those who love the Oxford comma a chance to run a victory lap across the internet.

But the resolution means there will be no ruling from the land's highest courts on whether the Oxford comma – the often-skipped second comma in a series like "A, B, and C" – is an unnecessary nuisance or a sacred defender of clarity, as its fans and detractors endlessly debate.

It appears the Maine Legislature has learned its lesson, at least. It revised the disputed state law last year to end ambiguity by adding new punctuation—but not in the way you might be thinking." (NYT, 10 Feb 2018) They added a slew of semi-colons.

I think this provides a real life example of the value of a core education: writing skills and good grammar will always be of value in the workplace both now and in the future.

Works Cited

Jerald, Craig D. Defining a 21st century education. For the Center for Public Education 2009

Scott, Cynthia Luna. The Futures of Learning 2: What Kind of Learning For the 21st Century.

United Nations Educational Scientific and Cultural Organization, Education Research and Foresight Working Papers, 14 November 2015

Soffel, Jenny. What are the 21st-century skills every student needs? World Economic Forum 10 Mar 2016. <https://www.weforum.org/agenda/2016/03/21st-century-skills-future>

Victor, Daniel. "Suit Over Oxford Comma is Settled, for \$5 Million and a Slew of Semicolons" New York Times 10 Feb. 2018, sec. A, pg. 11.

Sources

Voogt, Joke. and Roblin, Natalie Pareja. 21st Century Skills, Discussion Paper. Universiteit Twente, Report is prepared for Kennisnet.

http://opite.pbworks.com/w/file/attach/61995295/White%20Paper%2021stCS_Final_ENG_dfw.pdf

21st-Century Literacies: A Policy Research Brief. National Council of Teachers of English.

http://www.ncte.org/library/NCTEFiles/Resources/Positions/Chron1107_ResearchBrief.pdf

Framework for 21st Century Learning. Partnership for 21st Century Learning. Pub date 1/16

www.P21.org

A Crosswalk of 21st Century Skills. Hanover Research. www.hanoverresearch.com

Chu, S.K.W. et al. 21st Century Skills Development Through Inquiry Based Learning, Chapter 2.

Springer. 2017. <http://www.springer.com/978-981-10-2479-5>

Salpeter, Judy. 21st Century Skills: Will Our Students Be Prepared? 15 Oct 2003.

<https://teachlearning.com/news/21st-century-skills-will-our-students-be-prepared>.

Teaching and Learning 21st Century Skills: Lessons from the Learning Sciences. Asia Society

Partnership and for Global Learning. Rand Corporation. April 2012

<http://edglossary.org/21st-century-skills/>

The Future of Jobs and Jobs Training. Pew Research Center. 3 May 2017.

<http://pewinternet.org/2017/05/03/the-future-of-jobs-and-jobs-training>

Mahaffie, John B. Nine Skills That Will Help Make Our Children Future-Ready.

<http://www.wise-qatar.org/john-mahaffie-learning-future-job-skills>