

Electronic Theses and Dissertations, 2004-2019

2009

Guidelines For Twenty-first Century Instructional Design And Technology Use: Technologies' Influence On The Brain

Jennifer Gabriel
University of Central Florida

 Part of the [Educational Technology Commons](#), and the [Technical and Professional Writing Commons](#)
Find similar works at: <https://stars.library.ucf.edu/etd>
University of Central Florida Libraries <http://library.ucf.edu>

This Masters Thesis (Open Access) is brought to you for free and open access by STARS. It has been accepted for inclusion in Electronic Theses and Dissertations, 2004-2019 by an authorized administrator of STARS. For more information, please contact STARS@ucf.edu.

STARS Citation

Gabriel, Jennifer, "Guidelines For Twenty-first Century Instructional Design And Technology Use: Technologies' Influence On The Brain" (2009). *Electronic Theses and Dissertations, 2004-2019*. 4075.
<https://stars.library.ucf.edu/etd/4075>

**GUIDELINES FOR TWENTY-FIRST CENTURY
INSTRUCTIONAL DESIGN AND TECHNOLOGY USE:
TECHNOLOGIES' INFLUENCE ON THE BRAIN**

by

JENNIFER GABRIEL
B.A. University of Central Florida, 1999

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Arts
in the Department of English
in the College of Arts and Humanities
at the University of Central Florida
Orlando, Florida

Spring Term
2009

© 2009 Jennifer Sheehan Gabriel

ABSTRACT

The increasingly global environment has spurred the economy in the United States as well as the economies in nearly every other nation. Although the U.S. remains the world leader in the global economy, research shows that the United States is at risk of losing its place as the world leader in science and innovation.

Policymakers have recognized the need for research addressing global competitiveness. President Bush signed the America Competes Act, which calls for increased investment in innovation and education to improve U.S. competitiveness and President Barack Obama has named a platform, “Science, Technology and Innovation for a New Generation” which will extend and prioritize the efforts to improve math and science education.

K-12 U.S. students are graduating from high school unprepared to pursue degrees in science, technology, engineering and math (STEM) in college. Without STEM degrees they will be unable to pursue technology jobs after graduation. Statistics show that the U.S. is failing to produce as many graduates in STEM as other countries. In an increasingly global world, without graduates in STEM courses the U.S. is at risk of losing its position as the economic world leader.

Government, industry and academia all agree that the U.S. needs to address education on a K-12 level to ensure that U.S. students are equipped with twenty-first century skills to compete in a twenty-first century global economy.

Twenty-first century students are different from students of previous generations. Researchers argue that changes in the environment, specifically an increased exposure to

technology, have changed the brains of twenty-first century students; twenty-first century students learn differently.

However, twenty-first century students are being taught with an instructional curriculum that was designed for a previous generation that did not have the same exposure to technology. This is causing a digital-divide that is hindering the achievement of students. The instructional curriculum needs to be updated to meet the needs of twenty-first century students.

This thesis addresses this need from a technical communication perspective by arguing that the instructional design of twenty-first century learning materials should be improved by adhering to guidelines for twenty-first century learning characteristics and twenty-first century technology use. The guidelines support a national goal to improve K-12 achievement in order to increase U.S. STEM graduates and increase the U.S.'s ability to compete in a global economy.

ACKNOWLEDGMENTS

I would like to thank my thesis Chair, Dr. Madelyn Flammia for going above and beyond to support me through this process. She devoted a great deal of her time and effort to help me get to this point.

I would like to thank my thesis committee members, Dr. JD Applen and Dr. Kathleen Bell, for their guidance and support.

I would like to thank my family, especially my dad, William Sheehan, for their continued support.

I would like to thank Dr. Randall Gunter, whose passion for twenty-first century learning inspired this research.

I would like to thank Ian Jukes for allowing me to rely heavily on his research in twenty-first century learning.

TABLE OF CONTENTS

LIST OF FIGURES	VIII
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: REVIEW OF RELATED RESEARCH	8
Twenty-First Century Students in a Global World	10
Globalization and U.S. Competitiveness	10
U.S. Competitiveness and Education	12
Neuroinformatics	14
Twenty-First Century Technology Use	17
Technology Use by Young Adult	17
The Digital Divide	19
Technology in the Classroom	23
Video Games in the Classroom	24
Internet Tools in the Classroom	27
Other Technology in the Classroom	30
Implementing These Technologies into the Classroom Curriculum	30
Conclusion	33
CHAPTER 3: GUIDELINES FOR TWENTY-FIRST CENTURY INSTRUCTIONAL DESIGN	36
Twenty-First Century Visual Learning Characteristics	37
Twenty-First Century Cognitive Learning Characteristics	44

Twenty-First Century Affective Learning Characteristics	50
Visual learning.....	56
Cognitive learning	56
Affective learning	57
Conclusion.....	57
CHAPTER 4: GUIDELINES FOR TWENTY-FIRST CENTURY TECHNOLOGY USE.....	58
CHAPTER 5: CONCLUSION.....	76
Funding Opportunities	76
Contribution to the Field of Technical Communication	81
Areas of Future Research.....	86
APPENDIX: THESIS DEFENSE ANNOUNCEMENT	89
WORKS CITED	90

LIST OF FIGURES

Fig. 1. Heat Map Pattern, SirsiDynix, 22 Feb 2006.....	39
Fig. 2. Heat Map Pattern, SirsiDynix, 22 Feb 2006.....	39

CHAPTER 1: INTRODUCTION

Whenever civilization has gone through a major technological revolution, the world has changed in profound and unsettling ways. But there is something about the flattening of the world that is going to be qualitatively different from the great changes of previous eras. - Thomas Friedman, *The World is Flat*

In the past decade and a half the world has become more globalized. Technological advancements have spurred the economy in the United States as well as the economies in nearly every other nation. Thomas Friedman describes this as the “flattening of the world” (49). In *The World is Flat*, he argues that globalization is causing the world to go from round to flat; “hierarchies are being challenged from below or are transforming themselves from top-down structures into more horizontal and collaborative ones” (48). He argues that the flattening of the world is a fundamental shift comparable to the Industrial Revolution. This shift has leveled the playing field; other countries are becoming more competitive with the United States in terms of science and innovation.

Friedman argues that there are ten factors that led to increased globalization and the “flattening of the world.” (49). The first factor is the fall of the Berlin wall; which spurred the growth of a free-market economy. The second factor was an increase in global connectivity that was brought on with the advent of the Web and Netscape. Netscape was a powerful force, according to Friedman, because it made the Internet accessible to everyone; the Internet was no longer used only by the early adopters, those who were at the forefront of Internet use. The third force is the emergence of workflow software that allows people to transfer business

documents from one computer to another. The fourth force, "Uploading," allow users to author content and collaborate in online environments. The next two forces described by Friedman are overseas outsourcing and offshoring; outsourcing is the practice of hiring an overseas company to handle a sector of a company's business practices (e.g. call centers) and offshoring is the practice of moving an entire company overseas. These two forces helped to integrate other countries into the global economy. The next force that is flattening the world is "Supply-Chaining." Supply-chaining is the practice of using technology to streamline your production process. The next force is "Insourcing," which is when one company performs a service under the name of another to lower production costs. The ninth force Friedman refers to as "Informing." Informing is the use of online search engines like Google and Yahoo. With the emergence of these tools, Friedman argues, "everyday people are able to in-form themselves in their own language" (179). Informing has helped to form global communities. Friedman refers to the last force as "The Steroids." These include computing, text-messaging and file sharing, voice over Internet protocol (VOIP), videoconferencing, computer graphics and wireless technology devices. As a result of the "steroids," Friedman argues that "engines can now talk to computers, people can talk to people, computers can talk to computers, and people can talk to computers farther, faster, more cheaply, and more easily than ever before" (199).

All of these forces, according to Friedman, increased globalization by enabling other countries to participate in the global economy. The United States has reaped the benefits of globalization. In "Losing the Competitive Advantage: The Challenge For Science and Technology in the United States," Matthew Kazmierczak and Josh James report, that "economic forces have

compelled other countries to open their markets, slash tariffs, accept foreign direct investment, buy U.S. products, and adopt U.S. technology” (6). These occurrences have spurred the economy in the U.S. However, they have also spurred the economies in other countries as well. Kazmierczak and James report that increased globalization “presents unprecedented challenges to American preeminence” (6). Increased globalization spurs increased innovation in science and technology. As other countries adopt new technologies, they begin to develop new technologies as well. With the development of new technologies, other countries become more competitive in science and innovation. Less developed countries are often able to advance their economies at a faster rate. This phenomenon, according to Kazmierczak and James, is referred to as “leapfrogging.” Countries that do not already have technologies in place are able to implement the latest technologies at a lower cost than countries who need to update existing technologies. An example of the leapfrogging can be seen with the implementation of telephone service in underdeveloped countries. Kazmierczak and James discuss how it took the industrialized world nearly a decade to bring telephone service to its population with copper lines, whereas developing countries will be able to accomplish this “at a fraction of the time and cost because advanced wireless and satellite technologies allow nations to leapfrog over yesterday’s technology by utilizing the latest innovations” (6). This leapfrog effect is enabling other countries to catch up with the U.S. in science and innovation.

Another factor that is enabling other countries to catch up to the U.S. in science and innovation is advancements in education. Kazmierczak and James report that while other countries are producing more scientists and engineers at an increasing rate, “the number of

students entering these fields in the United States has remained flat” (7). They suggest that the reason for this is that “other countries place a greater emphasis on educating science and technology workers” (7).

A recent documentary, “2 Million Minutes,” examined science and technology education in India, China, and the United States. The documentary follows six high school students for four years of high school, which amounts to 2 million minutes. The film reports that students in China and India have a more aggressive curriculum for science and math courses than students in the U.S., and they are more motivated to learn these subjects. When interviewed, the students in India and China expressed a strong motivation to learn, especially math and science. They expressed a fascination with math and science and a desire to obtain positions in technology fields after graduation. However, the U.S. students in the documentary were more motivated by activities outside of the classroom and expressed little interest in obtaining technology jobs after graduation. The documentary received criticism for its portrayal of U.S. students. However, the documentary reports that as a result of the less aggressive curriculum and lack of motivation, U.S. students consistently score below both India and China in math and science in international comparisons. The documentary warns that that if U.S. students are unable to compete academically with students in India and China, they will be unable to compete for technology jobs in the global economy.

In a global economy for companies to remain competitive they will need to hire the best and brightest, and the documentary warns that companies in the U.S. will have to rely on workers from other countries to fill technology jobs. A short video, “Did You Know?” created by

Karl Fisch and Scott McLeod is often referenced in discussions of U.S. competitiveness. It reinforces the challenges that U.S. students may be facing after graduation by reporting that 100% of college graduates in India in 2006 spoke fluent English. It also reported that in ten years China will be the number one English speaking country by population. This reinforces the challenge that U.S. students may be facing by illustrating that not only will students in China and India be more qualified to fill technology jobs, they will be more qualified to fill technology jobs in the United States. Fisch and McLeod call for people to pressure the school boards to provide the resources for students to become “literate in the twenty-first century.” They also call for people to pressure elected representatives to effect changes in legislation that will better prepare students for the twenty-first century global economy.

Policymakers, industry executives, and educators have all joined the discussion to improve students’ ability to compete in a global economy. Discussions all lead to the fact that we need to improve K-12 math and science education in the U.S. The Obama administration’s education agenda cites the need for reform by asserting that “America faces few more urgent challenges than preparing our children to compete in a global economy” (Whitehouse.gov). Under the federal education agenda, the administration vows to “restore the promise of America’s public education, and ensure that American children again lead the world in achievement, creativity and success” (Whitehouse.gov). One of the specific goals of the education agenda is to “make math and science education a national priority” (Whitehouse.gov). Support at the Federal level is critical to our nation’s ability to effect real change and improve education in the United States. The support that the Obama

administration has vowed to dedicate to the effort provides an opportunity for all other industry sectors to do their part to contribute.

The goal of my research was to find a way to contribute to the effort from a technical communication perspective. How can the field of technical communication better prepare twenty-first century students to compete in a global economy? One of the greatest changes that has resulted from increased globalization is increased innovation in science and technology. As a result, students today have more access to technologies than students of previous generations. In my research I sought to explore how increased access to technology may impact the way the students learn. Initially, I consistently came across arguments on how twenty-first century students learn differently from students of previous generations as a result of constant exposure to multi-media technology. To explore the impact that technology has had on twenty-first century learning, I came up with three research questions:

1. How do twenty-first century students learn differently than students of previous generations?
2. In what ways does incorporating multimedia into the classroom curriculum facilitate learning?
3. In what ways might the instructional design of K-12 educational texts be adapted to meet the needs of twenty-first century students?

Increased access to technology has changed the way twenty-first century students live. They have never known a world without constant access to technology. This access enables them to find information and communicate with their peers anytime from virtually anywhere. Twenty-

first century students are the first generation to be born into this anytime, anywhere access. Using technology for information gathering and communication has become the natural preference for this generation. Since technology has changed the way they interact with the world, it stands to reason that it has also changed the way they learn. This research seeks to determine what has changed about how twenty-first century students process information and how they are motivated to learn.

Since twenty-first century students are primarily accustomed to processing information from digital mediums, they may not be accustomed to the style of non-digital mediums that may be used in classrooms. This research seeks to determine if exposure to technology has changed the way twenty-first century students process information and, if so, how the learning process can be adapted to address those changes. The research also looks at how technology can be implemented into the classroom to motivate students to learn. This research seeks to apply the findings directly to the field of technical communication to provide a contribution to the national effort to improve K-12 math and science education in order to better prepare students to compete in a twenty-first century global economy.

CHAPTER 2: REVIEW OF RELATED RESEARCH

I began my research with globalization and its impact on education and the economy in the United States. Discussions on globalization lead to discussions on the United States' ability to remain competitive in an increasingly global world. Discussions on improving U.S. competitiveness lead to discussions on improving education in the U.S. Efforts are being made by industry, government and education to improve the achievement of K-12 students in the United States so that graduates are better prepared to compete with foreign nationals in an increasingly global world. I have reviewed research related to my thesis in the following four areas: Twenty-First Century Students in a Global World; Neuroinformatics; Twenty-First Century Technology Use; and Technology in the Classroom. The first section, Twenty-First Century Students in a Global World, begins with statistical research on how globalization has increased in the past few decades. It presents arguments on how the increase in globalization is threatening the United States' position as the economic world leader. Arguments on how to improve the U.S.'s ability to compete in a global economy lead to arguments on the need to improve education in the U.S. Statistics on education show that the U.S. is failing to produce as many graduates in science, technology, engineering and math (STEM) as other countries. The statistics show that U.S. students are not prepared for these complex STEM subjects when they enter college. The research supports the need to address education on a K-12 level to ensure that U.S. students are prepared to pursue STEM degrees in college.

The next section, Neuroinformatics, presents neuroscientific findings on the brain's ability to change. Researchers argue that changes in the environment, specifically an increased exposure to technology, have changed the brains of twenty-first century students; twenty-first century students learn differently. This section presents theories, backed by experimental research, that suggest that this change in the brain is the cause of prolonged and increased exposure to technology. This section leads to the next section, Twenty-First Century Technology Use.

The section on Twenty-First Century Technology Use presents statistics on technology use by young adults. It also discusses how this technology use has impacted the way twenty-first century students learn; twenty-first century students learn differently from students of previous generations. They are motivated by different stimuli and process information differently. This section defines some of the specific characteristics of a twenty-first century learning style. It also presents arguments that suggest that these contrasting learning styles of twenty-first century students and that of previous generations have created a digital divide in the classroom that is hindering the learning process.

The last section of the research, Technology in the Classroom, presents different ways to implement technology in the classroom to facilitate learning. Increasing technology in the classroom is what many researchers argue will help to bridge the digital divide. The research presented in this section posits that the K-12 educational system should embrace digital natives' reliance on technological mediums due to their positive effects on learning.

Twenty-First Century Students in a Global World

Globalization 3.0 is shrinking the world from a size small to a size tiny and flattening the playing field at the same time. ... the thing that gives it its unique character – is the newfound power for individuals to collaborate and compete globally” – *The World is Flat*, Thomas L. Friedman

Globalization and U.S. Competitiveness

Globalization has increased dramatically in the past few decades. One reason for the increase is that policies on foreign trade have become less stringent, facilitating global trade and business practices. Another reason for the increase is advancements in technology that have enabled global communication, allowing different nations to share ideas and products that further innovation. This increasingly global environment has spurred the economy in the United States as well as the economies in nearly every other nation. Although the U.S. remains the world leader in the global economy, research from the Technology Association of America shows that, in recent years, the United States is at risk of losing its place as the world leader in science and innovation. In “Losing the Competitive Advantage?: The Challenge for Science and Technology in the United States,” Matthew Kazmierczak and Josh James argue that:

Policymakers, industry executives, community leaders, teachers, and parents need to recognize that the world is changing and that we had better adapt to this increasingly competitive environment if we hope to remain at the forefront of the technology revolution. (1)

Policymakers have recognized the need for research addressing global competitiveness; on August 9, 2007, former President Bush signed the America Competes Act, which calls for

increased investment in innovation and education to improve U.S. competitiveness. The goal of the legislation is to “keep America the most innovative nation in the world by strengthening our scientific education and research, improving our technological enterprise, attracting the world's best and brightest workers, and providing 21st century job training” (2007). This effort will be continued in the new administration. President Barack Obama has named a platform, “Science, Technology and Innovation for a New Generation” under which his administration will “make math and science education a national priority” (BarackObama.com). In a recent weekly address, while announcing his new Science and Technology Policy team, the President stated “I am confident that if we recommit ourselves to discovery, if we support science education to create the next generation of scientists and engineers right here in America; if we have the vision to believe and invest in things unseen, then we can lead the world into a new future of peace and prosperity” (Rochelson). His administration will support continued and increased investment in innovation and education under the America Competes Act and encourage Congress to approve funding for programs aimed at improving math and science education.

Industry executives have recognized this issue as well. According to the Partnership for 21st Century Skills Taskforce, “eighty-four percent of employers say K-12 schools are not doing a good job of preparing students for the workforce” (Partnership 2002 2). The *Partnership* represents individuals from U.S. companies, organizations and educational institutions in all 50 states (Partnership 2007 4). Their efforts are informed by their position that “international competition from nations with strong education systems and millions of highly educated, skilled workers roils markets—and the U.S. workforce—every day”(4). They argue that the U.S. must

take steps to improve education at a K-12 level in order to ensure students can remain competitive in an international workforce.

U.S. Competitiveness and Education

Statistics from the National Science Foundation show that while “the United States is the largest world economy and the fourth largest country by population, it only rank[ed] sixth in the number of bachelor degrees awarded in engineering in 2000” (Kazmierczak James 2005 7). Although high-tech employment grew by fifty-percent between 1990 and 2002, the number of bachelor degrees in engineering fell by six percent (19). Math and computer science degrees grew by 41 percent during this time, but included in that percentage are foreign-national graduates that may need to return to their respective countries after graduation (19). In 2002, foreign nationals represented 56 percent of the engineering degrees, 45 percent of the computer science degrees and 53 percent of the math degrees that are awarded in the United States (20). This is a large number of science, technology, engineering and math (STEM) course graduates that may be forced to return home under the stipulations of U.S. immigration policy and, therefore, unable to join the U.S. high-tech workforce. Without a strong high-tech workforce, the U.S. is at risk of losing its lead in innovation and the development of new technologies. A report put out by the CIA’s National Intelligence Council states that “the greatest benefits of globalization will accrue to countries and groups that can access and adopt new technologies” (13). To benefit from globalization and maintain the competitive advantage, the U.S. must ensure that U.S. students are pursuing degrees in STEM courses.

In order for students to pursue complex STEM courses in college, they must be adequately prepared for them on a K-12 level. Without a strong background in these subjects, students will be unprepared to earn technology degrees in college. They will also be unprepared to pursue technology jobs after graduation because “in an information economy, the majority of jobs—not just those specifically in high tech—require some grounding in science and math” (13). However, research suggests that the K-12 education system is inadequately preparing U.S. students to pursue degrees in STEM courses. In 2005, the *Third International Mathematics and Science Study* ranked U.S. performance in math and science; at the 12th grade level, out of twenty-one countries, the U.S. ranked 19th in math and 16th in science. According to data from the U.S. Department of Education’s National Assessment of Educational Progress (NAEP), last year in the areas of math and science “only 39 percent of 4th graders and 31 percent of 8th graders tested at or above proficient” (James Leary 1). Math and science proficiency must be addressed at this level to ensure that students are pursuing math and science degrees in college.

Ian Jukes and Anita Dosaj argue that increased and prolonged exposure to technology has had a profound effect on the way twenty-first century students learn. Technological advances have changed the way we live, do business and communicate. Twenty-first century students have never known a world without multimedia communication. In “Understanding Digital Kids,” Ian Jukes and Anita Dosaj describe these students, those born after 1980, as “digital kids (dks)”. They are “digital natives”; digital is their native tongue; “digital immigrants” or the “over-30 group” speak digital as a second language. They have researched, written and

communicated without the advantage of technology. As a result, digital kids are “differently neurologically” (2). Jukes and Dosaj argue that neuroscientific findings show that students today are “fundamentally differently than previous generations in the way they access, absorb, interpret, process and use information and above all, in the way they view, interact and communicate in the modern world (2).

Neuroinformatics

A fairly new field of neuroscience, neuroinformatics, involves the analysis of the brain processes by use of several scanning devices including: Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) scans and Optical Topography (OT). These devices allow the scientists to track which part of the brain is active when a subject feels an emotion, performs a task or processes information. Neuroinformatics tracks the movement of brain activity on a molecular level. In sum, the research from a digital-divide perspective shows that if the brain activity of someone over 50 was compared to that of someone around 30, there would be a slight difference in the neural pathways taken to process the same information. If the brain activity of someone around 30 years old was compared to that of a digital native (born after 1980), there would be a fundamental difference (Jukes and Dosaj 14). These findings suggest that the brains of twenty-first century students have changed.

Prior to these fairly recent findings, neuroscientists believed that the brain did not change beyond adolescence. It was thought everyone used the same neural pathways to process information. However, in recent years, advancements in neuroscience have found this

belief to be wrong. In fact, the brain is “constantly reorganizing itself structurally throughout life based on input or experience” (Jukes Dosaj 13). The first evidence of the brain’s ability to change itself was discovered by Dr. Michael Merzenich in 1968. Dr. Norman Doidge discusses Merzenich’s findings in his book *The Brain That Changes Itself*. This ability of the brain to change is called “neuroplasticity” (Doidge xix). Doidge uses a machine metaphor to describe this phenomenon: “If certain parts fail, then the other parts could sometimes take over” (Doidge xix). According to Doidge, while neuroplasticity can have a positive impact on brain function, the phenomenon “isn’t always good news: it renders our brains not only more resourceful, but also more vulnerable to outside influences” (xx). This structural reorganization of the brain caused by neuroplasticity creates a new brain map. Brain maps are the representations of how the brain is organized, so as the brain changes, the brain map order changes as well.

Brain Mapping

A brain map is organized topographically. This means that “the map is ordered as the body itself is ordered” (Doidge 65). For instance, “our middle finger sits between our index finger and our ring finger. The same is true for our brain map: the map for the middle finger sits between the map for our index finger and that of our ring finger” (65). The topographical nature of the brain was discovered when by Merzenich when he cut the hands of adolescent monkeys and sewed the cuts back together leaving the nerves severed. He anticipated that the wires would get crossed as the nerves regenerated and, for example, the signal of the thumb would be received in the map of the index finger. Instead, he found that the map was normal. The

map was typographical “as though the brain had unshuffled the signals from the crossed nerves” (55). The order could not be changed by physically severing the nerves. The typographical order of our brain, according to Merzenich, is formed because “many of our everyday activities involve repeating sequences in a fixed order” (65).

Merzenich relied on the theories of Donald O. Hebb to further his research in brain mapping. Hebb proposed that “learning linked neurons in new ways” (63). Hebb, along with Freud sixty years prior, suggested that “when two neurons fire at the same time repeatedly (or when one fires, causing another to fire), chemical changes occur in both, so that the two tend to connect more strongly” (63). This concept is simplified by Carl Shatz: “Neurons that fire together wire together” (63). Merzenich concluded that the “neuronal structure of the brain can be altered by experience” (63). Merzenich, along with behavioral scientist Bill Jenkins, experimented with this phenomenon further by testing a monkey’s ability to pay close attention. He rewarded the monkey for performing a task that required a great deal of attention and found that the monkey’s ability to increase its attention was increased by the use of the reward. This showed that “when an animal is motivated to learn, the brain responds plastically” (66). In their experiments, Merzenich and Jenkins, also found that “as neurons are trained and become more efficient, they can process faster” (67). The scientists found that experience, motivation and learning all cause the brain to act plastically and can cause the brain to change its typographical order.

The plastic nature of the brain causes it to change as experience changes. One of the most notable changes in the global culture, in the last decade, is the continual, exponential

increase in technology use. Based on the neuroscientific findings, an increase in technology use causes the brain of the user to change. These neuroscientific findings have been tested by scientific experimentation; Doidge presents results of experimentation that are suggestive of the brain's plastic response to an increase in technology use.

Twenty-First Century Technology Use

According to Doidge, a recent study of twenty-six hundred toddlers revealed that “early exposure to television ...correlates with problems paying attention and controlling impulses later in childhood” (307). This study is suggestive of the potential, plastic changes that over-exposure to electronic media can have on the brain. Edward Hallowell, a Harvard psychiatrist and expert on Attention Deficit Disorder (ADD) has linked electronic media to the “rise of attention deficit traits, which are not genetic, in much of the population” (307).

Doidge argues that it is the “cuts, edits, zooms, pans and sudden noises [of the medium]—that alter[] the brain by activation of what Pavlov called the “orienting response” (309). He posits that the reason why the nervous system is so easily altered by electronic media is that the nervous systems and electronic media operate very similarly. They “both involve the instantaneous transmission of electric signals to make linkages” (311).

Technology Use by Young Adult

The results from a 2008 survey by the Pew Internet Group and Life Project, a non-profit research organization that tracks the impact of the Internet on families and culture, reflect the

prolific use of technology by those ages 12-17. Some of the most notable statistics are as follows:

- 93% use the Internet regularly (Pew Social Network 3).
- 28% were bloggers at the end of 2006 (up from 19% at the end of 2004)(Pew Social Network 3).
- 97% play computer, web, portable, or console games—50% played games “yesterday” (Pew Video Games 2).
- 85% engage in some form of electronic personal communication, which includes text messaging, sending email or instant messages, or posting comments on social networking sites (Pew Writing 3).

According to the Pew statistics, although 87% of adults are online, only 51% of them use the Internet regularly (compared to the 93% of those between the ages of 12-17 that report regular use). Based on the neuroscientific findings of Doidge and Merzenich this difference in Internet experience between the two groups would create a difference in the brain map of the respective groups. Neuroscientist Dr. Gary Small, along with the help of UCLA neuroscientists Drs. Susan Bookheimer and Teena Moody, hypothesized that Internet searching would result in different brain activity between experienced Internet users and non-experienced users. Using Magnetic Resonance Imaging (MRI) scanning, the scientists tracked the brain activity of a group of experienced Internet users and compared it to the brain activity of non-experienced users while they were performing Google searches. The scan showed that the experienced users “used a specific network in the left front part of the brain, known as the dorsolateral prefrontal cortex” (Small Vorgan 16). The group with less experience showed “minimal, if any, activation in this region” (16). Significantly, after five days of the same exercise, the less-experienced group

started to show activity in the dorsolateral prefrontal cortex as well. There was no change, after five days, in the brain activity of the experienced group. These findings suggest that increased exposure will result in a change in brain activity. The results further support Jukes' and Dosaj's argument that the brains of digital natives, who are experienced Internet users, are different from the brains of digital immigrants, who are less-experienced Internet users.

The Digital Divide

Dr. Small uses the same terminology as Jukes and Dosaj to distinguish between those who were born into a world of technology, digital natives, and those who adapted to it later in life, digital immigrants. Dr. Small's theories support that of Jukes and Dosaj; he argues that the difference in technological experience between these two groups is "turning the normal generation gap into something new: a widening chasm [called] the brain gap" (24).

Another researcher in the field, Marc Prensky, who is credited with coining the terms "digital natives" and "digital immigrants," argues in "Digital Natives, Digital Immigrants," that this difference in exposure to digital media has created a generation of students who are "no longer the people our educational system was designed to teach" (Prensky 1). Digital natives, according to Prensky, are often being taught by digital immigrants, "who speak an outdated language (that of the pre-digital age)" (2); it is this difference in languages that causes a digital divide between the generations. Jukes and Dosaj argue that the foundation of this difference is that, unlike digital immigrants, digital natives "operate[] on twitch speed," giving them "instantaneous access to information, goods and services at the click of a mouse" (7). They

outline what they, along with other researchers have found to be the most significant differences between digital natives and digital immigrants that create the educational digital divide. For instance, digital natives prefer to receive information quickly; parallel process information; learn from pictures and video rather than text; have random access to information, such as a hyperlink style web page allows; interact with others while learning; receive instant gratification and learn what is not only relevant, but also fun. Conversely, digital immigrants prefer to receive information slowly; singular process; learn from text rather than pictures and video; prefer linear information rather than hyperlink; prefer to work independently; prefer deferred gratification and learn what is on the curriculum guide and the test.

In order for digital immigrant teachers to effectively communicate with digital native learners they need to understand their language. This, according to Jukes and Dosaj, does not require changing the focus of what is important in the lesson; it requires delivering the information in a way that facilitates their ability to receive it. Since the learning styles of digital immigrants and digital natives are so diametrically opposed, digital immigrant teachers will need to break their traditional habits and preferences in order to deliver information effectively to digital natives. They will have to make some adjustments such as increase the speed of instruction, incorporate multiple technological mediums into the lesson plans and provide or allow Internet access for “just in time” information retrieval. Digital immigrants will be teaching digital natives for at least a few more decades. During that time, Jukes and Dosaj argue that the digital immigrants need to learn the language of the digital natives and deliver information to

their digital students in their language. Then, classrooms may be able to bridge the digital divide and boost achievement on a K-12 level.

Although the digital divide is narrowing as digital natives are becoming educators and parents, it is critical that, in the meantime, digital natives are being taught in a language that they understand. Getting digital natives to speak in the language of digital immigrants is not a plausible option. According to Prensky, the idea of teaching them to learn the language of the immigrants “flies in the face of everything we know about cultural migration” (3). Children “born into any new culture learn the new language easily, and forcefully resist using the old” (3). We must find ways to teach digital natives in a language that they understand.

In “How People Learn: Brain, Mind, Experience, and School,” Bransford, Brown, Cocking and Rodney expand on this phenomenon and break down their findings on the changes in neurological pathways into three conclusions:

1. Learning changes the physical structure of the brain.
2. These structural changes alter the functional organization of the brain; in other words, learning organizes and reorganizes the brain.
3. Different parts of the brain may be ready to learn at different times (103).

The conclusions reflect that drastic changes in environment cause drastic changes in the neural pathways.

Apple, Inc. has expanded on this issue to determine what about digital literacy changes the way digital children process information. Apple researchers determined that long-term exposure to multi-sensory stimuli retrains their neural pathways to gather information in

different ways. The result of the retraining has created a group of students who are hyper-communicators, multi-taskers and goal oriented. Apple researchers present these findings in their report, “Digital Tools for Digital Students.” They report that digital students cannot retain information unless it is obtained through multi-sensory stimuli. Their solution, one with an obvious vested interest, is to incorporate multi-media tools into the learning process (Digital Tools).

Despite their potential to gain from this initiative, Apple is a valued member at the table of many task forces aimed at improving education through technology. Their efforts are supported by organizations that represent all sectors including education and government. One organization, The Partnership for Twenty-First Century Skills, has brought all sectors to the table. “Maximizing the Impact: The Pivotal Role of Technology in a twenty-first century Education System,” reports that technology is largely missing from efforts aimed at improving education despite the fact that technological advancements have fueled the growth of other industries. *The Partnership* calls for education to look to other industry sectors and model their technology adoption after them. They also call for government funding and regulation of educational improvement initiatives. Their proposal is informed by the group assertion that “computing engages students and boosts achievement” (The Partnership 13).

The Partnership also suggested in a previous report, “Learning for the Twenty-First Century; A Report and Mile Guide for Twenty-First Century Skills,” that the key to improving education for twenty-first century students is to find ways to “bridge the gap between how

they live and how they learn” (Partnership 5). They report that there are six key elements to focus on for effective twenty-first century learning:

1. Emphasize Core Subjects.
2. Emphasize Learning Skills.
3. Use Twenty-First Century Tools to Develop Learning Skills.
4. Teach and Learn in a Twenty-First Century Context.
5. Use Twenty-First Century Assessments that Measure Twenty-First Century Skills (Partnership 6).

The Partnership’s six key elements support the idea that twenty-first century students learn differently and need to be taught differently than students of previous generations.

Other researchers have tried to isolate the differences in how twenty-first century students learn. Ian Jukes and Anita Dosaj argue that the greatest teaching challenge of this generation is teaching reading and writing; reading and writing, in a traditional sense, which relies on hard-copy, paper texts for reading and a pen and paper for writing, are a form of delayed gratification unlike the instant gratification that students get from digital mediums with faster speeds of operation. Scholars call this instant gratification “twitch speed” and suggest that you cannot keep the interest of a digital kid without it (Jukes and Dosaj 7).

Technology in the Classroom

According to researchers, Jukes and Dosaj, overexposure to digital media has changed the way that digital natives process information. It has also shown that we cannot reverse the effects that this phenomenon has had on the learning process. However, many researchers

suggest that the K-12 educational system should embrace digital natives' reliance on these technological mediums due to their positive effects on learning.

Video Games in the Classroom

Marc Prensky is one researcher at the forefront of the effort to use digital media to enhance education. In his book, *Don't Bother Me Mom—I'm Learning*, he discusses how computer games and other digital media can improve thinking skills. Thinking skills that were improved include "representation competence" (36), which is the ability to recognize images as being representations of a three-dimensional object; "multidimensional and visual-spatial skills" (36), which is the ability to imagine the process of doing a physical task without actually doing it; "inductive discovery" (36), which is the scientific process of formulating hypotheses based on observations; and "attention deployment" (36), which is the ability to focus on several things at once and react faster to stimuli.

Prensky also addresses the claim that video games have a negative impact on attention span. He argues that as a result of their prolonged exposure to digital media, digital natives crave interactivity. It is not that they cannot pay attention; it is that they "choose not to" (36). Prensky does concede that the ability to reflect may be hindered in digital natives as a result of video games and digital media. He suggests that that "instructor-led questioning and debriefing" (37) may help to encourage students to reflect on their experiences.

To support his claim that video games can enhance learning, Prensky details a study conducted by Lightspan Partnership, which is a sector of Plato Learning. Lightspan determined

that after time is deducted for recess, lunch and classroom interruptions, an average school day consists of about three hours of actual instruction. Their goal was to design a video game that would be fifty-percent educational. If a student spent six hours over a weekend (an amount of time they determined to be average), they would add a whole class day to weekly instruction. It was important, however, to make the game compelling for the students because they would have to choose to play this game instead of another game. They spent over 100 million on the game and tested it in over 400 school districts. The results showed that the game-playing students increased their vocabulary and language skills by “almost 25 percent over the non-game-playing control groups, and by over 50 percent in math problem solving” (38).

Prensky suggests that the best approach for implementing an educational environment that employs the use of video games and other digital media is to incorporate the model used for the development of video games; a model that consists of three elements: the player, the designer and the seller. The player is not limited in offerings, the designer is always trying to keep the interest of the player and the seller always has the audience in mind. This model, according to Prensky will perpetuate an effective model for a digital educational environment as it does a thriving video game industry. Prensky argues that because content for most academic subjects is standard (for less advanced subjects), in the future, learning tools will be measured by their ability to motivate. In today’s terms: “gameplay rules! Why? Because gameplay motivates!” (90).

Video games have also been introduced as an effective learning aid for twenty-first century students by Mahboubeh Asgari & David Kaufman. In *Relationships Among Computer*

Games, Fantasy, and Learning, the researchers discuss how the theme of curiosity and fantasy that are characteristic of video games help to motivate learning by keeping students interested. They suggest that there are five basic guidelines for designing video games that will facilitate learning. The guidelines are:

1. Use fantasy to reinforce instructional goals, not compete with them;
2. Provide appropriate metaphors and analogies for learning;
3. Provide imaginary characters that are familiar to the learner;
4. Accommodate gender differences in fantasies; and
5. Relate the fantasy to the content to be learned (Asgari Kaufman 6).

John Paul Gee expands on the concept that video games can facilitate learning. In his essay in *Wired* magazine, "Hi Score Education," he describes video games as "successful models of effective learning." He argues that

video games incorporate the principle of expertise. They tend to encourage players to achieve total mastery of one level, only to challenge and undo that mastery in the next, forcing kids to adapt and evolve. This carefully choreographed dialectic has been identified by learning theorists as the best way to achieve expertise in any field. (Gee 1)

He posits that effective educational aids can be designed by gamers despite the fact that they are not cognitive scientists. The reason for this, he suggests, can be explained by free-market economics. If the games aren't challenging, they don't sell. The games are challenging, according to Gee, because they require the user to gain an expertise at one level only to be sent to the next level to start over attempting to gain expertise there. This forces the user to "adapt

and evolve” (1). Gee argues that this “carefully choreographed dialectic has been identified by learning theorists as the best way to achieve expertise in any field” (1).

Internet Tools in the Classroom

The Internet is another tool that has been found to be an effective learning aid. Will Richardson, an internationally-regarded evangelist for the use of Internet technologies in the classroom, discusses Internet tools in his book *Blogs, Wikis, Podcasts and Other Powerful Web Tools for Classrooms*. Richardson argues that despite the fact the Web tools may not be

well-suited to a climate of standardized test scores and government accountability...these tools have considerable relevance to state and local core content curriculum standards, and there is much reason to believe their implementation in schools will better prepare students for a slew of new literacies and competencies the their post-education lives. (5)

He argues that because these tools are relatively easy to employ by a digital native or a digital immigrant they may be effective at narrowing the digital divide in the classroom. If they were too difficult to use, he argues, the amount of online content would not have exploded as it has in recent years. Another important factor that helps to facilitate implementation of the Web tools into the classroom is that fact that they are free to use. He posits that the lack of barriers provides an optimistic expectation that “once the potential of [these tools] finds its way into schools, students and teachers will be launched on a path of discovery and learning like they have never experienced before” (7). The tools that Richardson is referring to when he refers to “the toolbox” are: Weblogs, Wikis, Rich Site Summary (RSS), Aggregators, Social Bookmarking, Online Photo Galleries and Audio/video-casting.

A Weblog (blog) is an “easily updateable Website that allows an author (or authors) to publish instantly to the Internet from any Internet connection” (17). Richardson argues that they are effective educational tools because they are “constructivist”, they allow students and teachers to add to a “larger body of knowledge” (27); they “expand the walls of the classroom”; they “archive learning”; they support different personality styles (a shy person may be more apt to speak out on a weblog than in a face-to-face class); they support expertise on specific subject; and they “teach students new literacies that they will need to function in an ever expanding information society” (28).

According to a study by Fernet and Brock Eide’s, blogs (excluding social networking sites such as Myspace and Facebook) can have a positive impact on student’s learning process.

They found that blogs can:

- Promote critical and analytical thinking
- Be a powerful promoter of creative, intuitive, and associational thinking
- Promote analogical thinking
- Be a powerful medium for increasing access and exposure to quality information
- Combine the best of solitary reflection and social interaction (20).

Another Web tool promoted by Richardson is a wiki. A wiki is a “website where anyone can edit anything anytime they want” (59). Wikis are effective educational tools according to

Richardson, because they foster collaboration, teach publishing and encourage writing.

However, there are risks involved in incorporating Wikis in the classroom. Along with the freedom to write and edit anything the user wants, comes the risk of being misinformed.

Richardson also discusses the effectiveness of Real Simple Syndication (RSS) and aggregator software in the classroom curriculum. RSS, which is generated by XML, enables the user to get information from a Weblog without going visiting the Weblog page. When users subscribe to the feed, the information is automatically delivered to them.. Aggregator software collects all of the feeds that the user has subscribed to in one location. This allows users to “create [their] own collections of news and features that are personalized to [their] interests” (76). Richardson suggests that these tools improve the efficiency of the classroom curriculum because students can be “immediately updated when new information about research topics is published” (77).

In addition to providing students with instant up-to-date information, the Web also allows users to find and share information with other people with similar interests with social bookmarking sites. Social bookmarking sites allow people to collect bookmarked pages in a public forum where others with similar interests will be able to share resources. Using these sites is like “creating your own community of researchers that is gathering relevant information for you” (91). Richardson argues that it is beneficial to use these sites in the classroom because it has the “potential to lead us to more and better information” (93).

Richardson also discusses the educational benefits of Web sites that allow users to publish and edit photos. These sites allow students to share photos with a larger, global audience, which introduces them to different cultures and environments.

Podcasting and screencasting are also presented by Richardson as effective educational tools that are available on the Web. Podcasting, “the creation and distribution of amateur

radio” (112) and screencasting, the captured video of the user’s activity on a computer screen along with the audio, are both effective educational tools on the Web as they allow the design of customized lesson plans and supplemental learning material that may help to motivate students to learn.

Other Technology in the Classroom

Personal Digital Assistants (PDAs) have also been found to motivate students to learn. A study conducted by the non-profit research and development firm, SRI International, concluded that the use of PDAs had a positive impact on student learning; ninety-three percent of the teachers in the study reported that the PDAs improved learning. They helped the students write papers, fact-check, synchronize their technologies and collaborate with group members. The teachers also reported that additional applications would be necessary for measurable benefits of handheld devices. They provided suggestions for educational software designed for handhelds as well as suggestions for use. SRI found the results to be exciting because with previous technologies such as the Internet, the teachers had to agree to change their methodology or teaching perspective before the incorporation of the technology could take place effectively. Getting the teachers to agree to the change was often difficult. In this case, however, the teachers embraced the technology, the PDAs, immediately.

Implementing These Technologies into the Classroom Curriculum

Some researchers offer solutions on how to incorporate all of these elements into a course framework. Gary Shelly and Tom Cashman, scholars in the field of classroom technology

integration, have put out a textbook, *Teachers Discovering Computers: Integrating Technology and Digital Media in the Classroom*. The book introduces teachers to the latest technology and provides information on how to incorporate these technologies into the classroom.

Susan Cramer discusses the process of incorporating technology in the classroom in *Update Your Classroom with Learning Object and Twenty-first Century Skills*. Cramer breaks down the process of technology integration into three phases: “Print Automation,” “Expansion of Learning Opportunities” and “Data-Driven Virtual Learning” (131). In Phase I, “Print Automation”, computers are used as an occasional tool rather than an everyday necessity. For example, final papers may be printed on a computer, but the previous versions may have been hand written. In Phase II, “Expansion of Learning Opportunities,” students use technology to find information and to communicate with others outside of the classroom. Phase III, “Data-Driven Virtual Learning”, incorporates the other two phases, but it expands the role of technology in the classroom to include the presentation of solutions to real-world problems to others outside of the classroom. Cramer argues that technology can increase student learning and suggests that teachers take steps to transform their classrooms to incorporate technology to “better meet the needs and work habits of today’s millennial students” (131).

Some researchers argue that although technology in the classroom can be an effective way to enhance learning, simply incorporating the technologies is not enough. “In *Learners and Learning in the Twenty-First Century: What Do We Know About Students’ Attitudes Towards and Experiences of Information and Communication Technologies That Will Help Us Design Courses?*”, Adrian Kirkwood and Linda Price discuss how Information and Communication

Technologies (ICTs) can be effective tools for improving learning, however, “learning can be enhanced when innovations take into account not only the characteristics of the technology, but also the pedagogic design, the context within which learning takes place, student characteristics and their prior experience, and familiarity with the technologies involved” (260). Since these factors will vary among the students in a classroom, it would be impossible to ensure that the learning outcomes, expected from the incorporation of the technology, will be achieved. The researchers conclude with three issues that should be addressed before incorporating ICTs into the classroom. The first is to consider the diverse background and experiences of the students, the second is to anticipate a varied hardware and software (if the students are expected to use their own equipment) and the third is to make sure the students have online as well as offline time to work.

As the research in this section of the review indicates, technology in the classroom can be an effective way to facilitate learning for twenty-first century students. However, there are many variables to consider for effective implementation. So, including an exercise that requires the use of technology into the instructional design of a twenty-first century lesson plan may be an effective way to facilitate learning for twenty-first century students. However, to be effective, the inclusion of the technology component should be informed by the variables presented in this research such as the context within which learning takes place, prior experience of the students, and the students’ familiarity with the technologies.

Conclusion

The research in this review supports the need to update the instructional design of twenty-first century learning materials as part of an overall need to improve education on a K-12 level. The K-12 educational statistics reflect that students in the United States are not achieving academically at the same level as students from other countries. According to the competitiveness research, without strong K-12 achievement, U.S. students will not be prepared to pursue technology degrees in college or to work at technology jobs after graduation. Industry, government and education all seem to agree that we need to do something to improve twenty-first century education in order to remain competitive in a global workforce. Since research has shown that today's K-12 students are different from students of previous generations, it only stands to reason that education should change to meet the needs of this generation.

So, research suggests that twenty-first century students learn differently and their learning can be enhanced with technology. The research supports the use of technology in a twenty-first century classroom as a means to facilitate learning, but calls for guidelines for technology incorporation. From a technical communication perspective, research is needed on how to improve twenty-first century instructional design to contribute to the overall effort to improve education. Incorporating the research in this review, I argue that the instructional design, meaning the creation and compilation of the content and the tools for facilitating learning, of twenty-first century learning materials can be improved to meet the needs of twenty-first century students by adhering to a few guidelines that are based on the needs of

twenty-first century students. There are two sets of guidelines. The first set of guidelines focuses on Twenty-First Century Learning Characteristics. This set of guidelines centers on the research of Jukes and Dosaj and is informed by a knowledge of twenty-first century learning characteristics. Twenty-first-century-learning characteristics are the learning characteristics of twenty-first century students that are different from those of previous generations. They are preferences for learning that have changed as a result of constant exposure to technology. These were outlined by Jukes' and Dosaj's research and backed by neuroscientific findings. The second set of guidelines, guidelines for twenty-first century technology use, will be guidelines for incorporation of technology into instructional design of twenty-first century learning materials. These guidelines are informed by the large body of research presented on the positive effects that technology can have on the learning process. However, the guidelines will not be based solely on the need to have technology in the classroom. As the research shows, just implementing the technology is not enough to ensure that the desired outcomes are achieved; the technology must be used effectively. For this reason, the guidelines will be based on The National Educational Technology Standards (NETS), which are standards for technology proficiency that measure the skills of K-12 students against a set of skills needed to be technologically fluent in today's environment. The guidelines are skill-based; they are designed to help instructional designers select which technologies to incorporate into learning materials based on a set of skills that the student should acquire as a result of the technology use. The skill-based guidelines for twenty-first century technology use will help to ensure that the instructional design incorporates the technology mediums effectively into the design so

students can meet the NETS benchmarks and be technologically fluent to compete in a global world.

This thesis argues that the instructional design of twenty-first century learning materials can be improved by adhering to guidelines for: twenty-first century learning characteristics and twenty-first century technology use. These guidelines will represent a contribution from the field of technical communication to the overall improvement of education in the U.S. and, in turn, the competitiveness of the United States.

CHAPTER 3: GUIDELINES FOR TWENTY-FIRST CENTURY

INSTRUCTIONAL DESIGN

Researchers have theorized that twenty-first century students learn differently from students of previous generations. Neuroscientific findings and scientific studies support these theories. Constant exposure to technology has literally changed the brains of twenty-first century students. They think differently than students of previous generations. The difference has had a profound effect on the learning process; students are being taught with a curriculum that was designed for previous generations that had less exposure to technology. To facilitate learning, learning materials need to be developed that address the learning characteristics of twenty-first century students. These characteristics are preferences for certain ways of learning that have changed as a result of constant exposure to technology. I will call these characteristics twenty-first century learning characteristics. Based on research I have found on twenty-first century students, I have outlined the characteristics that have developed or changed as a result of constant exposure to technology. I have divided the twenty-first century learning characteristics into three categories: visual learning characteristics, cognitive learning characteristics, and affective learning characteristics. All of the learning characteristics that I cover are significant because they reflect characteristics that have changed as a result of exposure to technology. Twenty-first century visual learning characteristics reflect the way twenty-first century students perceive information that they see; twenty-first century cognitive learning characteristics reflect the way twenty-first century students process information; and

twenty-first century affective learning characteristics reflect the way twenty-first century students feel about learning.

Twenty-First Century Visual Learning Characteristics

Twenty-first century students, digital natives, according to Jukes and McCain, are more inclined toward visual processing than previous generations. A study by Bavelier and Green, researchers at the University of Rochester, explains why digital natives are more inclined toward visual processing. The study revealed that people who played video games for a few hours a day over the course of a month showed improved results in visual acuity tests similar to those used in ophthalmological vision exams. Bavelier and Green report their findings in “Action – Video – Game Experience Alters the Spatial Resolution of Vision.” The findings showed that after just 30 hours of game play, the “spatial resolution of visual processing is enhanced”, meaning the users’ ability to process the images on the visual acuity tests was enhanced. As mentioned in Chapter 2, PEW statistics show that 97% of digital natives reported to play video games and 50% of those reported playing “yesterday” (Pew Video Games 2). Considering the average game takes about 40 hours to play, it is likely that most digital natives have reached the 30-hour threshold. Therefore, it is likely that most digital natives have enhanced visual processing abilities as a result of video game play.

To further support this theory that digital natives have become more inclined toward visual processing, Jukes and McCain report the results of a 3M study that revealed that when digital natives were shown 100 photographs, they were able to recall 90% of the images.

However, when digital immigrants were shown the same photographs, they were able to recall 60%. The constant exposure to television, video games, and other technologies has honed the visual abilities of digital natives. These mediums do not rely solely on text to convey meaning to the user; meaning is conveyed with visual cues such as color and graphics. For digital natives visual cues are a more natural way to make meaning. For this reason, it is critical that instructional materials are designed to meet their increased inclination toward visual learning, their twenty-first century visual learning characteristics.

One of the most basic twenty-first century visual learning characteristics, that differs from the learning characteristics of previous generations, is the way the eyes of twenty-first century learners navigate a page. In the 2008 version of the report, "Understanding Digital Kids," which was originally released by Ian Jukes and Anita Dosaj in 2004, Ian Jukes and Ted McCain cite a study conducted at Kent State University on how twenty-first century students navigate a page differently than previous generations. Scientists at Kent State University, Holmes et al., along with researchers at SirsiDynix, a company in Toronto, used heat maps to study the patterns of eye movements of twenty-first century students as they navigated different reading materials. The results, presented in "Report on the Usability and Effectiveness of SirsiDynix SchoolRooms for K-12 Students," showed that the students typically read in what is commonly referred to as a Golden Triangle or an F-Pattern. This pattern can be seen in Fig. 1 and Fig. 2. The figures are "static representation[s] of the fixation points of all of the students combined into one view" (23). The more time the students spent looking at an area, the more red the area appears in the figure. Holmes et al., report that "subjects tend not to scroll down"

and information “below the fold is typically not seen” (23). As seen in the images, K-12 students tend to ignore the right-hand margin and the bottom of the page. However, the report did find that the students would move their eyes to the bottom and the right if they were highly motivated to do so. Older generations, according to Jukes and McCain, would start 1/3 of the way down the page and 1/3 from the left side and read in a “Z curve” (26).

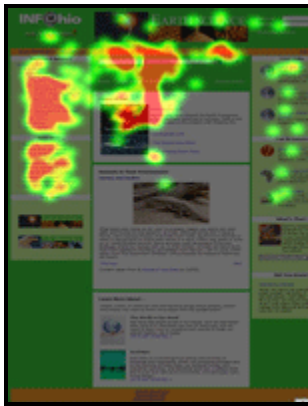


Fig. 1. Heat Map Pattern, SirsiDynix, 22 Feb 2006



Fig. 2. Heat Map Pattern, SirsiDynix, 22 Feb 2006

Jakob Nielsen, one of the foremost experts on web design has researched the implications of the F-Pattern of eye movement in web design. In his report, “F-Shaped Pattern for Reading Web Content,” he discusses how the F-Pattern has three parts, and how they are navigated in a specific order. First, the eyes of the reader move across the top bar of the “F” in a horizontal pattern. Second, the eyes of the reader move across the second bar of the “F” in the same horizontal pattern, and third the eyes scan the left-side, forming the stem of the “F”. Nielsen argues that the speed of this final vertical step varies, but the pattern itself is typical. Neilson states that there are three implications of the “F-Pattern”. The first is that users will not read the text word-for-word; they will scan over groups of information. Second, they will read

more of the first two paragraphs than they will anything else, so the most important information should be included in paragraphs one and two. Information in subsequent paragraphs should be kept short, so the user will be able to make meaning from them with only a glance. Third, the user will scan down the left margin, so informative words should be placed in the headings and subheadings. The amount of text that a user reads decreases as the user moves down the left margin, so the amount of text should decrease down the page as well.

The guidelines that Nielsen proposed for F-Pattern design should be applied to all twenty-first century learning materials. Jukes and McCain have argued that twenty-first century students read in an F-Pattern in all “different reading configurations” (26), so the F-Pattern for digital natives extends beyond reading on the Web. For this reason, Nielsen’s F-Pattern design represents the first visual learning guideline for twenty-first century instructional design:

1. Instructional design should adhere to an F-Pattern, placing the important information in the frame of the “F” and/or using design techniques that motivate students to look outside the “F”.

Adhering to an F-pattern design does not necessarily require that the designer refrain from using space outside of the “F”. However, for students to effectively make meaning from information outside of the “F”, designers must use motivating design techniques that draw the user’s attention to that area. The next two visual learning guidelines discuss ways to motivate students to move their attention outside of the “F” by designing for twenty-first century visual learning characteristics.

The next twenty-first century visual learning characteristic that differs from previous generations involves the perception of color in text. According to Jukes and McCain, “while digital immigrants typically find it distracting to read text of different colors, specific colors attract and repel digital natives when they’re reading” (26). In order for students to be motivated to learn, they need to be drawn to the instructional material; they must be motivated to direct their attention to the text; digital natives are more motivated by color in text than previous generations. Jukes and McCain state that blood red captures a male’s attention first and pink a female’s, green and burnt orange are only skimmed and black is ignored unless the user is highly motivated to read the text. Text color is an important preference to consider since most of the content of learning materials is done in black text. So, the next visual learning guideline for twenty-first century instructional design is:

2. Color should be used in text to motivate the user to navigate to important information.

Since there is not a lot of information about what specific colors can be used to motivate twenty-first century students, the most important component of this guideline is that the content in instructional design should not be so heavily reliant on black text. One way to use color effectively would be use black text within the “F” pattern and use color outside of the “F” to draw the student’s attention to the information to which they are not naturally drawn.

The third visual learning characteristic that separates twenty-first century students from previous generations is a graphics-first preference for receiving information. They prefer to learn from graphic-rich content rather than plain text whereas previous generations prefer

plain text and find too many graphics distracting. Twenty-first century students think graphically. In “Twitch Speed: Keeping Up With Young Workers,” Marc Prensky uses *Wired* magazine as an example of the difference between digital natives’ and digital immigrants’ preference for graphics; *Wired*’s graphically-rich design is appealing to young audiences, but difficult for older generations to read (1). In “Digital Natives, Digital Immigrants Part II: Do They Really Think Differently?,” Prensky argues that this graphics-first preference can have profound implications for the learning process, yet it is “almost totally ignored by educators” (5). For previous generations, graphics were generally used to accompany text to clarify meaning that the text conveyed. However, the roles of text and graphics are now reversed. For digital natives, text is used to accompany graphics to clarify meaning that was “first experienced as an image” (32).

The graphics-first preference for learning is referred to as the “pictorial superiority effect or PSE” (Medina 233). In *Brain Rules*, John Medina discusses this phenomenon and its effects on learning and memory. Medina discusses experiments where the effects of pictures were compared to that of text and oral presentations in terms of their ability to facilitate the retention of information. He argues that the results showed that texts and oral presentations “are not just less efficient than pictures for retraining certain types of information; they are *way* less efficient” (234). He argues that “if information is presented orally, people remember about 10 percent, tested 72 hours after exposure” (234). However, “the figure goes up 65 percent if you add a picture” (234).

Since twenty-first century students have had more exposure to graphic-rich content than previous generations, I would argue that the pictorial superiority effect is more pervasive in twenty-first century learning. Medina suggests that educators should harness the power of the PSE by learning how “pictures grab attention” (237). He argues that with the “advent of web-based graphics, the days when this knowledge was optional for educators are probably over” (237).

Thus, the final visual learning characteristic of twenty-first century students is that they prefer graphic-rich content. For this reason the last visual learning guideline for twenty-first century instructional design is:

3. Instructional design should use less text and more graphics to convey meaning.

Again, graphics would be an effective way to motivate students’ attention outside of the “F-pattern”. The graphics outside of the “F” could provide the initial meaning, while the text inside the “F” could provide the accompanying clarification. Since their eyes of the students’ are naturally drawn to the graphics as well as the information within the “F,” this placement may help to ensure that the students are motivated to make meaning from all of the content on the page.

The three visual learning guidelines can all be used together to ensure that students are motivated to make meaning from content. Understanding that twenty-first century students are more inclined toward visual processing is important in designing twenty-first century

instructional materials. Adhering to these twenty-first century visual learning guidelines will help to facilitate learning for twenty-first century students.

Twenty-First Century Cognitive Learning Characteristics

Twenty-first century students also differ from previous generations in how they process information. Due to constant exposure to technology, they prefer to process information from multiple stimuli simultaneously and quickly. The characteristics that define the way that twenty-first century students process information will be presented under twenty-first century cognitive learning characteristics.

The first, most notable, cognitive learning characteristic is that twenty-first century students prefer parallel processing, or multi-tasking, while previous generations preferred singular processing, or single-tasking. Parallel processing is processing multiple pieces of information or stimuli at once, while singular processing is processing only one at a time, moving on to the next only after finishing the first. Twenty-first century students prefer to give only a portion of their attention to a specific task and prefer “randomly toggling between tasks deciding which one to do next” (31). Jukes and McCain note that at any given time, digital natives can be found:

sitting at a computer, doing their homework, watching *American Idol*, listening to music, burning a CD, searching for something online, while simultaneously managing 14 instant messenger conversations..and they're still bored (31).

Twenty-first century students are a generation of multi-taskers. Jukes and McCain report that

students claim that performing multiple tasks at the same time “helps them concentrate” (31). Despite their preference for a parallel processing, multi-tasking learning characteristic, twenty-first century students are often asked to adapt to singular-processing learning in the classroom. Since many educators are from a previous generation and prefer singular processing and limited tasking, they tend to teach students in a singular style. Multimedia devices that are used regularly outside of the classroom and facilitate multi-tasking are often banned in the classroom. Transitioning to a limited-tasking environment in the classroom, according to Jukes and McCain, forces the twenty-first century students to “slow it down or dumb it down in order to function” (31). The research of Jukes and Dosaj has shown that students learn more effectively when they are motivated to learn. If students are bored by instruction that requires single processing, then the learning process may be hindered.

Some researchers, however, argue that multi-tasking may have adverse effects on learning. In *Born Digital: Understanding the First Generation of Digital Natives*, John Palfrey and Urs Gasser state that according to psychologists, “kids learn better if they pay full attention to the things they want to remember” (191). They also argue that the “the adverse effects of multitasking on children’s ability to learn new facts and concepts has been supported by brain-imaging studies” (191). Palfrey and Gasser posit, however, that the “higher levels of distraction associated with multitasking [may be] outweighed by the overall gains in productivity” (191). To support their position, Palfrey and Gasser reference a classroom study conducted to determine the effects of multi-tasking on learning. The study is presented in “The Laptop and the Lecture: The Effects of Multitasking in Learning Environments” by Helene Hembrooke and Geri Gay. In

the study, two groups of students listened to the same lecture and were tested on the material immediately after. One group was allowed to use their laptops during the lecture to browse, email and socialize while the other group was asked to keep their laptops closed. The group that were allowed to use their laptops “suffered decrements on traditional measures of memory for lecture content” (1). However, “while students were obviously distracted [by multitasking] as evidenced by their performance on traditional tests of memory, their performance in the class overall does not reflect this same disruption” (15). The students were allowed to multitask throughout the semester and the average grade was a high “B.” If the course grades were determined by test of memory, Hembrooke and Gay argue, the results may have been different; the students may have scored lower as a result of multitasking. Hembrooke and Gay conclude that short-term memory may be hindered by multitasking due to the brain’s limit in the amount of information that can be consumed at once. However, the overall learning is not negatively impacted. They also argue that the negative impact that multitasking can have on memory can be negated “if students can become better browsers, or at the very least become more facile at self-monitoring their browsing behavior” (16).

Based on the findings of Hembrooke and Gay, I would argue that the psychological perspective that multitasking may negatively impact learning is based on an outdated measure for learning. As mentioned in Chapter 2, research suggests that twenty-first century learning needs to place more focus on the higher order skills needed to compete in a digital environment. These higher-order skills, as presented by Jukes and McCain, can be obtained more easily when students are motivated learn, and students are motivated to learn in a

multitasking environment. For this reason, I would argue that the positive effects that multitasking can have on learning outweigh the possible negative effects. Additionally, the possible negative effects such as a hindrance in short-term memory may be negated, according to Hembrook and Gay, by “setting boundaries and establishing tech-etiquette for using wireless technologies in the classroom” (16).

For this reason the first cognitive learning guideline for twenty-first century instructional design is:

1. Instructional design should provide opportunities for multi-tasking.

There are numerous ways that student’s can multi-task within the classroom. For example, multi-media devices can be encouraged to allow students to collaborate with other students or find additional information on a topic. However, there are also ways to include multi-tasking that do not require that each student has access to these devices. There are a plethora of free web tools available to students that allow them to process information from multiple stimuli. Incorporating a learning component that encourages multi-tasking does not need to call for the use of a specific technology. Rather, the design can simply encourage the student to perform a task or find information by looking somewhere outside of the instructional material.

In addition to preferring to process multiple tasks at one time, digital natives also prefer to perform these tasks at a quicker pace. This pace is commonly referred to as “twitch speed”. Because of their constant exposure to various technological mediums, digital natives have become accustomed to processing information more quickly than previous generations. Again,

when they enter the classroom, digital natives are forced to slow down. Since many educators are from a different generation, they prefer a slower release of instructional information. According to the research of Jukes and Dosaj, digital natives are unable stay motivated and interested when operating at slower speeds. For this reason, the next cognitive learning characteristic of twenty-first century students is that they operate at “twitch speed”. The next cognitive learning guideline for twenty-first century instructional design is:

2. Instructional design should allow for access to information at “twitch speed”.

Presenting the information in “twitch-speed” in instructional materials may include breaking the information into smaller modules of information. Presenting the information in small amounts does not mean providing less information, it just means providing it in smaller bits. “Twitch-speed” is characteristic of the manner in which students receive information through multi-media devices such as video games; the information is delivered quickly in small bursts. In small modules, students can jump from module to module faster.

Allowing for “twitch-speed” access to information, however, also requires the incorporation of a technological medium into the instructional design of learning materials. Again, “twitch-speed” learning does not need to require that students all have access to their own technological devices. Rather, the design needs to encourage that students look outside of the instructional material to gather additional information. “Twitch-speed” information gathering will require that the students are also allotted classroom time for online research.

The next cognitive learning characteristic of twenty-first century students is closely

related to the preference for “twitch speed”. The speed at which the digital generation has been able to access information is partly facilitated by their instant access to information. The Internet provides the opportunity to access information at any time from virtually anywhere. Search engines such as Google allow digital natives to find information at the very instant that they need it, and hypertext allows them to delve deeper into topics when more information is needed and continue on when more is not. Jukes and Dosaj refer to this as “just-in-time” access to information (24). Just-in-time methods such as random access and hyperlinks are the natural processes of information access for digital natives, yet often they are thrust into a classroom environment designed for step-by-step instruction. Jukes and Dosaj argue that this is one of the primary causes of the digital divide. For this reason, the final cognitive learning characteristic for twenty-first century students is that they prefer “just-in-time” access to information. The last cognitive learning guideline for twenty-first century instructional design is:

3. Instructional design should enable more just-in-time learning.

This last guideline may be more challenging because ideally students would need constant access to technology to get information “just-in-time”. Simply designing learning materials for “twitch-speed” does not provide students the ability to get additional information whenever they need it. For this reason, I argue that the portion of the learning material that encourages students to gather additional information is presented and covered while students have online access.

These three cognitive learning guidelines can be used together to ensure that instructional materials are designed so that students are able to effectively process information. By understanding that twenty-first century students have different preferences for processing information: a preference for multi-tasking, twitch-speed and just-in-time access to information, instructional designers can create learning materials that are designed for these specific preferences. This will help facilitate learning for twenty-first century students.

Although multi-tasking, twitch speed and just-in-time learning can help facilitate learning for twenty-first century students, researchers argue that these preferences can lead to information overload. Palfrey and Gasser discuss the implications of information overload on digital natives. They argue that, although there is no evidence that information overload is “a major health or other societal issue at the moment, the hallmarks of a big problem in the making are plain” (194). Palfrey and Gasser suggest that digital natives need to be provided with the “skills and tools they need to avoid information overload in the first place” (194). They also suggest that there should be strategies in place “that will be effective against information overload when it inevitably occurs” (194).

Twenty-First Century Affective Learning Characteristics

Twenty-first century students are not just different in how they learn, but also in how they feel about their learning experiences. According to Jukes and McCain, the emotional reactions that twenty-first century students have towards learning experiences differ from the emotional reactions of previous generations. I am referring to these emotional reactions as the affective

learning characteristics of twenty-first century students. Twenty-first century students want their learning to be relevant and they “want to know what possible connections [their learning] has to them and their world” (34). They also want their learning to be “fun most of the time”(34). Despite the fact the students want learning to be relevant and fun, Jukes and McCain report that only:

39% [of 12th grade high-school students] believe that school work will have any bearing on their success in later life; only 28% of 12th-grade high school students believe that school work is meaningful; 21% believe that their courses are interesting (35).

The first two twenty-first century affective learning characteristics are that twenty-first century students prefer learning to be relevant and fun.

To learn effectively, according to Jukes and Dosaj, students must be able to connect the new information to their real world experiences. In his book, *Information Anxiety II*, Richard Saul Wurman reinforces the importance of making real-world connections in learning by positing that “you only learn things relative to something you understand” (267). He traces this phenomenon back to Aristotle’s observation that memorization of a piece of information is increased by one’s ability to associate that piece of information with something already known. He asserts that “failing to make connections between the known and the unknown prevents us from grasping new ideas and new opportunities” (261). Wurman argues that the grouping of ideas is the best way to facilitate learning and “comparisons enable recognition” (270). So, based on the theories of Jukes and McCain and Wurman, the first affective learning guideline for twenty-first century instructional design is:

1. Content should make connections to students' real-world experiences.

Eric Jensen discusses the importance of making real-world connections to learning in his book *Completing the Puzzle: The Brain-Compatible Approach to Learning*. In this book, Jensen uses neuroscientific research to formulate a strategy for learning that is based on the brain's natural ability to learn. He argues that one of the keys to a brain-compatible approach to learning is the process of "determining personal relevance" (121). He argues that "learning that is integrated through reflection and personal relevance is the learning that will last" (121). Determining personal relevance also, according to Jensen, will "make school and education rewarding, rich and timeless", it also "spurs intrinsic motivation to learn" (121). To support his theories on the importance of personal relevance, Jensen poses an example of a student who studied ecology for a year. He asks which student would be better prepared to apply the learning to the world: a student who passed a written test or a student who went from 0 percent recycling to 75 percent. He argues that the best way to determine that personal relevance has been established is "through interviews, journals, class discussion groups and demonstration" (121).

Encouraging students to make connections to their real-world experiences may be as simple as adding a component to the learning material that requires that students apply what they have learned to their own life. For example, the learning material could pose a blog topic that encourages students to join in a dialogue about how they would apply the lesson to their own life. This exercise would not only encourage the students to analyze real-world

applications, but it would broaden their perspective by encouraging them to read other students' entries.

Twenty-first century students' preference for learning that is relevant to their real life is closely aligned with their preference for learning that is fun. According to Jukes and McCain the key to effective learning is not getting the students to learn, but getting them to "want to learn" (35) and "without motivation there is no learning" (35). According to Marc Prensky, parents and teachers often equate a lack of motivation in the classroom to a short attention span. Distractions are often blamed for students' inability to stay motivated in the classroom. In *Don't Bother Me Mom—I'm Learning*, Prensky argues that it is not that they can't pay attention, it's that they "choose not to" (36). To support his theory, Prensky references a study done for *Sesame Street* to test the attention spans of children against distractions. The purpose of the study was to determine if distractions hinder the ability of students to absorb and retain content in the classroom. For the study, a group of children were divided into two groups. Both groups were shown the same program on television; one room was filled with toys and the other was not. Not surprising, the children with the toys watched the television 47 percent of the time while the children without the toys watched 87 percent of the time. When tested on the content of the program, however, the students scored the same. They concluded that "the children could gain no more from increased attention" (36). The children's ability to absorb and retain the content on the program did not change as a result of distractions. This study suggests that, in a classroom setting, learning is not facilitated by the elimination of distractions; learning is facilitated by the student's interest in the content. The *Sesame Street* study further supports

the theory that learning can be facilitated for twenty-first century students if the learning is fun. So, simply, the next affective learning guideline for twenty-first century instructional design is:

2. Content and instructional design should make learning fun by incorporating elements such as game play and puzzles.

Encouraging game play does not need to rely on video games and technological devices.

Although these devices would be an effective way to motivate students, there are other ways to make learning fun. The instructional design, for example, could include a module that encourages students to take advantage of some of the free online educational games, such as those offered by *Funschool.com*. Or, the instructional design could simply encourage students to form groups and perform for the class something relevant to the lesson.

All of the twenty-first century learning characteristics that I have covered so far have been based on twenty-first century preferences, learning preferences that resulted from constant exposure to technology. The last twenty-first century learning characteristic, however, is not based on a preference; rather this characteristic is based on something that researchers argue has been lost as a result of constant exposure to technology. Unlike previous generations, twenty-first century students seem to have a diminished ability to reflect on their experiences. The fast pace of their environment allows little time for reflection. Prensky argues that one of the most challenging aspects of teaching digital natives is finding ways “to include reflection and critical thinking in their learning” (37). He posits that reflection enables us, “to generalize, as we create mental models from our experience” (37). It is the process of reflection that

enables us to learn from our experiences. For this reason, it is important for twenty-first century students to be encouraged to reflect on their experiences and their learning. So, the last affective learning guideline for twenty-first century instructional design is:

3. Each lesson should include a module for students to reflect on what they have learned.

The reflection module is similar to the real-life experience module. These two modules could be incorporated into one or handled similarly. The real-life experience module would encourage students to make real-life connections to learning and the reflection module would encourage students to reflect on their experiences and their learning in order to form mental connections. For example, the students can be encouraged to blog about the experiences or even simply write a short essay reflecting on the experience of the lesson.

In *Completing the Puzzle*, Jensen argues the importance of reflection as well, but suggests that reflections are most effective in learning when students' emotions are elicited through reflection. He argues from a neuroscientific approach and posits that learning should be compatible with the way the brain naturally learns best. Jensen suggests that a brain-compatible approach should allow students to "generate emotions about the material presented" (31). Jensen suggests that the learning approach should "purposely create emotion-inducing experiences and then provide an arena to process the feelings" (31).

Jensen uses neuroscience to support his arguments on the importance of emotional reflection. He states that the mid-brain area, called the amygdala, links emotional responses to information. There is a greater number of neural fibers extending out to the neocortex, or outer

area of the brain, than there are extending from the neocortex to the amygdala. The greater number of neural fibers reflects a biological prioritization of emotional information in overall brain function. Jensen argues that this makes sense from a survival standpoint; if the brain experiences fear, it will tell the body to prioritize that information. For this reason, Jensen argues that “emotions are more important to the brain than higher-order thinking skills” (28).

The twenty-first century affective learning guidelines will help instructional designers recognize that twenty-first century students are motivated to learn when learning is fun and when learning has relevance to their real-world experiences. Making learning fun, encouraging students to make real-world connections to learning and encouraging students to reflect on the learning process will help to facilitate learning for twenty-first century students.

The visual, cognitive and affective learning guidelines in their entirety are as follows:

Visual learning

1. Instructional design should adhere to an F-Pattern, placing the important information in the frame of the “F” and/or using motivating design techniques to draw students’ attention to areas outside of the “F”.
2. Color should be used in text to motivate the user to navigate to important information.
3. Instructional design should use less text and more graphics to convey meaning.

Cognitive learning

1. Instructional design should provide opportunities for multi-tasking.

2. Instructional design should allow for access to information at “twitch speed”.
3. Instructional design should enable more just-in-time learning.

Affective learning

1. Content should make connections to students’ real-world experiences.
2. Content and instructional design should make learning fun by incorporating elements such as game play and puzzles.
3. Each lesson should include a module for students to reflect on what they have learned.

Conclusion

Using these three sets of guidelines will help instructional designers design twenty-first century learning materials that meet the needs of twenty-first century students. The guidelines are intentionally unspecific. Many of the guidelines can be adhered to by incorporating the use of technology into the curriculum. The research in chapter two makes some powerful arguments about the benefits that technology in the classroom can have on the learning process.

However, I make no attempt to give specifics about technologies or their implementation. I only offer examples to help instructional designers brainstorm what would be effective in their specific instructional design projects. The guidelines are designed to be useful in any classroom regardless of the potential variables such as the context within which learning takes place, prior experience of the students, and the students’ familiarity with the technologies.

CHAPTER 4: GUIDELINES FOR TWENTY-FIRST CENTURY

TECHNOLOGY USE

Although the guidelines in Chapter 3 do not recommend the use of specific technologies, this thesis does argue that technology should have a significant role in a twenty-first century instructional design. Since technology has such a significant role in how twenty-first century students live outside of the classroom, it is important that technology plays a significant role in the classroom as well. In “Learning for the Twenty-First Century: A Report and Mile Guide for Twenty-First Century Skills,” the Partnership for Twenty-First Century Skills argued that the key to improving education for twenty-first century students is to find ways to “bridge the gap between how they live and how they learn”(Partnership 5). Incorporating technology into the classroom will help bridge that gap. Focusing on achieving proficiency with specific technologies, however, is not an effective means to ensure that students have sustainable technology fluency as the technologies available are constantly changing. This chapter will lay out specific guidelines for incorporating technology into the design of instructional materials. However, the guidelines will not be based solely on the need to have technology in the classroom. As the research shows, just implementing the technology is not enough to ensure that the desired outcomes are achieved. Technology use should be measured by a pre-determined set of desired aptitudes that should be achieved through the implementation of educational technology.

For this reason, the guidelines will include The National Educational Technology Standards, released by The International Society for Technology in Education (ISTE), a non-profit membership organization that seeks to improve education through the effective use of technology. The standards were originally designed to identify the basic technology skills that students need to achieve in an increasingly digital world. The standards, however, have recently been updated to “shift away from competency with technology tools to technology use that focuses on skills required in a digital world to learn, plan, produce, and innovate” (ISTE 6). This more comprehensive approach to technology use not only identifies basic technology skills, but also demonstrates how to measure that they are being used effectively to enhance the learning process. The standards include six categories of achievements. The ISTE reports that these standards are “widely adopted by districts as well as colleges and ministries of education...[and] are also used by more than 90% of U.S. states and many countries.”

The guidelines that I propose will also incorporate what Jukes and McCain call “twenty-first century fluencies” (42). These fluencies parallel the NETS standards in many ways, but focus on “higher-level thinking” (41). Jukes’ and McCain’s fluencies represent a transition from “passive receiving of information and traditional learning” (51) to “active participation and engagement with information” (51). Jukes and McCain argue that without these fluencies, students “will absolutely not be prepared for what awaits them after they finish school” (42). Jukes’ and McCain’s twenty-first century fluencies are based on what they consider to be a need for students to develop a “transparent use of digital tools to perform a wide range of tasks” (42). They argue that the use of technology should be an unconscious skill and that

ideally students should “just intuitively know what to do” (42). The twenty-first century fluencies define a set of unconscious skills that are honed through technology use that can be called on intuitively to create and innovate in an increasingly digital world.

I combine the NETS and Jukes’ and McCain’s twenty-first century fluencies into a comprehensive set of guidelines for technology use in twenty-first century instructional design. These guidelines will help to ensure that the instructional design incorporates technology effectively into instructional materials so students can be technologically fluent and have the skills to compete in a global world. The guidelines do not include specific technologies; rather, they focus on a set of skills that should be achieved as a result of technology use. I will start by outlining each NETS as it is presented by the International Society for Technology in Education. Then, I will explain how I have adapted or further supported it with additional research into a guideline for technology use in instructional design.

The first NETS is:

Demonstrate creativity and innovation: Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology (ISTE 9).

Under this standard, achievement is measured by a student’s ability to use technology to produce new material from existing knowledge as well as create original material as a means of self-expression. Traditionally, creativity has not been a significant part of the learning process. In *A Whole New Mind*, Daniel Pink relays a story about the late Gordon MacKenzie, who was a longtime “creative force” (68) at Hallmark. MacKenzie would visit schools to talk about his work at Hallmark. When he asked the students to raise their hands if they were artists, all of the

first graders would raise their hands, three-fourths of the second graders and only a few of the third graders. By sixth grade, no students raised their hands. He stated that by that time the students would not admit to “what they’d now learned to be deviant behavior” (69).

Pink argues a need to change this trend in the classroom. He stresses the importance of having an aptitude for creativity in today’s business climate. Creative design, he argues, is a “high concept aptitude that is difficult to outsource or automate—and that increasingly confers a competitive advantage in business” (86). Having an aptitude for design, in Pink’s view, will better prepare twenty-first century students to compete in a global workforce by making them more valuable and harder to replace. Pink argues that design is one of the most powerful economic drivers; it has replaced price in terms of the best way to gain a competitive advantage and it has the “capacity to create new markets” (81). Pink argues that design can also change the world. He discusses how good design of hospitals and doctor’s offices has been found to speed up healing, and bad design of election ballots has been blamed for altering the outcome of elections. Based on the NETS standard and supported by Daniel Pink’s “design” aptitude, the first guideline for twenty-first century technology use in instructional design is:

1. Technology use should foster creativity and design.

This guideline is based on Pink’s definition of design as a whole-minded aptitude. He explains that design in this context is “a combination of utility and significance” (70). Pink gives an example of this concept of design by describing a brochure. A graphic designer will need to make the brochure easy to read, which is the “utility” of the design. However, the designer will also need to “transmit ideas or emotions that the words themselves cannot convey” (70); this is

the “significance” of the design. “Utility” according to Pink is “L-Directed Thinking” whereas “significance” is “R-Directed” (70). Since “utility” has “become widespread, inexpensive, and relatively easy to achieve” (70), it is critical for students to develop an aptitude for combining “utility” with “significance” in order to compete in a global workforce.

There are an abundance of technological mediums that will help foster students’ ability to create and design. Web 2.0, the second generation of the Internet, is often referred to as the participatory Web because it allows users to participate in the creation of content. User-created content sites (UCCs), also referred to as user-generated content sites (UGCs), allow students to contribute their own content to an existing website or create content on a blank page. UCCs include social networking sites, weblogs, and photo publishing sites. UCCs allow for the creation of what Palfrey and Gasser refer to as “derivative works” (117). Derivative works are built on “existing creative works, like songs, videos, and text, to form a new creation” (117). Different type of derivative works include: mashups, fan fiction and sampling. “Mashups” or remixes are digital collages that “build upon the rich tapestry of digital content already spread across cyberspace” (115) This post-modern form of creativity is popular among twenty-first century students, according to Palfrey and Gasser, because “digital natives have developed excellent research skills when it comes to digging up digital materials that can be remixed...to create new forms of expression” (116). “Sampling” involves taking a piece from a song or piece of media and reusing it as part of a new creation. “Fan fiction” involves using characters from “TV shows, movies, books, cartoons...to develop new plots, settings, or situations for them” (117). Palfrey and Gasser argue that digital natives are increasingly engaged in UCCs like those

that enable the creation of derivative works. They argue that the “phenomenon is truly global” and is “one of the hallmarks of the emerging global culture of digital natives” (113). For this reason, Web 2.0 and UCCs may be valuable additions to twenty-first century learning.

UCCs might also be valuable tools for students because they are available on the Internet and are often free of charge. According to the Department of Education’s National Center for Educational Statistics, as of 2005, 100% of public schools in the United States had computers with Internet access with roughly 3.5 students per computer (NCES). These statistics show that students would have reasonably equitable access to these tools. These tools as well as many others may help students acquire the twenty-first century skills to design and create.

In addition to the ability to create, the NETS also include standards for technology use that fosters communication and collaboration.

The second NETS is:

Communication and collaboration: Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others (ISTE 9).

Jukes and McCain discuss the importance of technology use that enables communication and collaboration; they refer to this higher-order literacy as media fluency. They argue that “it’s not just that a particular medium is being used or about how it’s being used, it’s about how well the medium is being used to communicate the message” (43). Media fluency is about understanding how different digital mediums are used to communicate. It is also about creating content and communicating in digital environments “as effectively with visual and auditory elements as [previous generations] were taught to communicate with text” (43). Digital natives

will in most cases enter the classroom with this aptitude, but encouraging them to apply it to learning will help them reap the full advantages of digital-media communication outside of the classroom.

We know from the Pew statistics presented in Chapter 2 that students spend ample time outside of the classroom communicating with peers using digital media and online social networking sites. According to Richard Saul Wurman, it is during these types of voluntary interactions that most learning takes place. In *Information Anxiety II*, Wurman states that learning is simply the process of remembering communication. He states that “information feeds all communication in that the motivation behind all communication is to transfer information from one mind into another who will receive it as new information” (60). Information becomes trapped in the minds of the receiver more effectively when it is received through person-to-person communication. For this reason, he argues, “the most universal information trap is the one that inevitably occurs when attempting to communicate information” (60). Wurman’s arguments support the need for a twenty-first century proficiency with technologies that foster communication and collaboration. Without effective communication, according to Wurman, learning is hindered.

The results of a recent study, conducted by the MacArthur foundation, support Wurman’s emphasis on the importance of communication for learning. The Digital Youth Project is the most extensive study on the use of digital media by teens. The study, presented in *Living and Learning with New Media: Summary of Findings from the Digital Youth Project*, concludes that twenty-first century education should embrace technologies that foster

communication and collaboration. Social networking sites, for example, that allow students to communicate in a “friendship-driven” environment are “jumping-off points for experimenting with digital media creation and self-expression” (35). The report suggests that rather than seeing social networking sites “as hostile to learning” (35), educational programs could embrace the fact that social networking sites motivate students to “move from friendship-driven to more interest-driven forms of new media use” (35). In other words, by encouraging students to use social networking sites to communicate with their peers, educators are preparing students to use digital environments to communicate for educational purposes. The report uses the term “networked publics” to describe the “public culture that is supported by online networks” (10) The report argues that “in addition to reshaping how youth participate in their given social networks of peers in school and their local communities, networked publics also open new avenues for youth participation through interest-driven networks” (11). Interest-driven networks are online groups that enable users to connect and communicate with others on specific topics of interest. These topics could include anything from video gaming to artistic interests. The report admits that encouraging the use of social networking in education “requires a cultural shift and a certain openness to experimentation and social exploration that is generally not characteristic of educational institutions” (35).

The second guideline, which is based on the NETS, Jukes and McCain’s concept of media fluency, Richard Saul Wurman’s position on the role of communication in learning, and the findings of the Digital Youth Project is:

2. Technology use should enable communication and collaboration.

One example of a technology that can be used to enable communication and collaboration is Gaggle.net. Gaggle is a free email service for students and teachers that requires nothing more than Internet access. Since it is a web-based service, students can access their accounts from any computer with Internet access. Gaggle may be preferable to other email services because it is monitored by teachers, which makes it a safe environment where students can enhance their ability to communicate and collaborate using digital mediums.

Although some environments, like Gaggle, are controlled and monitored by teachers, students have access to a plethora of available information via digital mediums that are not monitored or controlled by teachers. Students need the skills to evaluate information on their own. The next standard focuses on the ability to evaluate information gathered through technology.

The third NETS is:

Research and information fluency: Students apply digital tools to gather, evaluate, and use information (ISTE 9).

Jukes and McCain define information fluency, which is one of their higher-order skills, as “the ability to unconsciously and intuitively interpret information in all forms and formats in order to extract the essential knowledge and perceive its meaning and significance” (44). They outline five steps to information fluency. The first step is the ability to ask good questions; the second is the ability to obtain relevant material from a variety of sources; the third step is the ability to determine which sources are reliable; the fourth step is the ability to apply the findings to real life; and the fifth is the ability to assess the overall process (44).

In order for twenty-first century students to acquire an aptitude for information fluency, they need to be motivated to gather information. As Chapter 3 discusses, digital natives are more comfortable using technology to gather information; they are accustomed to twitch speed access to information. Jukes and Dosaj argue that asking them to slow down this access in the classroom is one of the primary reasons for the digital divide. Students need to be able to operate at twitch speed to be motivated to gather information. Only then can they acquire the skills to evaluate and use the information effectively. The third guideline for twenty-first century technology use in instructional design is:

3. Instructional design should incorporate technology that enables students to gather, evaluate and use information effectively.

There are many ways to incorporate technology that will enable students to gather, evaluate and use information. Online researching is one effective method. In “The Digital Disconnect: The Widening Gap Between Internet Savvy Students and Their Schools,” Douglas Levin and Sousan Arafeh argue that the Internet is the virtual reference library for twenty-first century students outside of the classroom. The Internet also serves as their virtual textbook, tutor, study group, guidance counselor and locker (6). Levin and Arafeh reported that students feel that when they use the Internet for research their “papers and projects are more likely to draw upon up-to-date sources and state-of-the-art knowledge” (iii). Students reported a desire to increase the amount of Internet access they had in the classroom.

The report includes recommendations from the students on how to increase and improve Internet access in the classroom including “insist[ing] that policymakers take the digital

divide seriously and understand the more subtle inequities among teenagers that manifest themselves in differences in the quality of student Internet access and use” (24). The report concludes by suggesting that schools should prioritize the increase of Internet access in the classroom or students “are likely to be increasingly dissatisfied with conventional approaches to teaching and learning” (25).

Although it is a valuable resource for students to effectively gather, evaluate and use information, the Internet can also be a source of unreliable information. Since there is a plethora of unreliable information on the Internet, students will need to develop their ability to evaluate what information is reliable and what is not. Jukes and McCain argue that students need to have the skills to “analyze and authenticate the acquired data to distinguish between the good, the bad and the ugly of information – to distinguish between fact and opinion – to understand bias – and in the process to turn the data into usable knowledge” (44). These are skills that need to be developed with guided online research practices.

Researchers argue that incorporating video games into learning is another way to develop online research skills. Kurt Squire and Constance Steinkuehler argue in “Meet the Gamer” that research is “a core component of game play. Gamers find and interpret data...publish results through game forums...and build spreadsheet models to compare the effectiveness of strategies” (40).

As Squire and Steinkuehler reinforce, the need for new twenty-first century aptitudes have developed as a result of technological developments. Students need to develop aptitudes for new skills such as online researching in order to compete in a digital, global world. However,

some of the twenty-first century aptitudes, such as critical thinking skills, have been a consistent focus in education for generations. The next standard focuses on using technology to develop critical thinking skills.

The fourth NETS is:

Critical thinking, problem solving, and decision making: students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources (ISTE 9).

Analytical skills such as critical thinking, problem solving and decision making have always been important workplace aptitudes. However, the ability to apply these skills using digital tools and resources is a fairly recent and ever-growing workplace necessity.

Daniel Pink expands on the need for analytical skills by arguing that, in an increasingly digital world, students need to expand their critical thinking, problem solving and decision making abilities. He argues that what is in greatest demand today isn't just analysis but "synthesis—seeing the big picture, crossing boundaries" (66). Without the ability to analyze, one will not be able to develop the ability to synthesize. Synthesizing concepts involves finding relationships between different things in order to create something new. The fourth guideline for twenty-first century technology use in instructional design is:

4. Instructional design should incorporate technology that encourages analysis as well as synthesis

Marc Prensky argues that video games are a great way to develop analytical skills. In "Don't Bother Me MoM – I'm Learning," he argues that games include the need to make decisions on "what to do, when to do it, how to plan ahead and prepare, and what strategy to use with (and

against) whom in order to move you toward your goal” (61). According to Prensky, feedback on the decisions made in video games is delivered instantaneously and in a manner that is easy to understand (61). The immediate feedback helps to improve users’ aptitude for thinking analytically and making effective decisions. Additionally, the kinds of decisions that users have to make in video games “are not just what to do and how to get past obstacles,” they are also decisions about themselves and whether their skills are good enough or if they need more practice and whether they can accomplish the task on their own or if they need outside help (62). Prensky argues that developing an aptitude for making effective decisions, like those that are required to progress in video games, is beneficial to learning because they are “decisions we all face in daily life” (62).

Pink offers suggestions for different ways to develop the aptitude for synthesis such as reading the news and making connections to the students’ own life. Another example is for students to Google a topic of interest, click on one of the search results, click on a link on that page, and then click on another link on that page, reading the information as they go. After about ten clicks, the topic will likely be much different than it was when the student started. Reflecting on how the different topics are interconnected allows the student to synthesize the information. There are many different way to foster students’ ability to analyze and synthesize through the use of technology by encouraging students to make connection between two seemingly unrelated concepts. Using technology to hone their abilities to analyze and synthesize will better prepare students for an increasingly digital world.

In an increasingly digital world, students not only need to be able to use the technologies effectively to develop twenty-first century aptitudes, they need to be able to use technologies safely. The next standard involves applying safety measures to protect students in a digital environment.

The fifth NETS is:

Digital Citizenship: Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior (ISTE 9).

Jukes and McCain include digital citizenship under one of their twenty-first century fluencies, online social fluency. They argue that although online social networking sites, such as Facebook and Myspace make great efforts to make their sites safe for users, the sites are only safe if the user makes good judgments (45). For this reason, many school districts have strict policies in place banning online social networking sites. However, in their report, "Creating & Connecting: Research and Guidelines on Online Social—and Educational—Networking," the National School Board Association (NSBA) argues that security concerns for these sites are exaggerated and by banning these sites educators are missing an opportunity to use them for educational purposes. They report that 59% of students say they have discussed college planning on social networking sites and 50% have discussed schoolwork on them. They also report that "nonconformists," or those who have admitted to defying the school's safety policies for online social networking, "are on the cutting edge of social networking, with online behaviors and skills that indicate leadership among their peers" (2). The NSBA recommends that schools revisit their policies on social networking sites. The organization makes recommendations for finding a compromise

between keeping students safe online yet allowing them access to these twenty-first century tools. The recommendations include asking educators and decision makers to explore the sites and use them for staff communication. After they are comfortable with the technologies, the recommendations encourage the decision makers and staff to find ways to incorporate the technologies into the learning process. They also suggest that educators encourage the creators of online social networking sites to increase the educational value of their sites. They suggest that educational leaders work with social networking sites to develop applications or encourage the formation of specialty groups that are educationally focused (9). Based on the NETS and the findings of the National School Board Association, the next guideline for twenty-first century technology use in instructional design is:

5. Technology use should be guided but not limited by a set of safety policies.

Before students can effectively use safe practices in digital environments, they must first be able to effectively use the tools to access these environments. The next standard focuses on need for students to develop proficiency for the use of technology in classroom.

The Sixth NETS is:

Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems, and operations (ISTE 9).

Jukes and McCain argue that technology proficiency is the most important twenty-first century fluency for students and teachers to have in a digital environment. Technology proficiency, they argue, is not about mastering the tools; it's about using the tools to perform a task. They use a pen as a metaphor to describe this concept. The user does not have to think about the pen; the

pen is the medium between the user's brain and the paper. The same is true for technology; the purpose of the task is not about

learning Excel – it's about using Excel to solve a problem. It's not about using Word – it's about using Word to write. It's not about [using PowerPoint] – it's about using PowerPoint to communicate effectively (42).

Students should have a mastery of the operations of the technology, so the performance of a task is not limited by the student's level of technological proficiency. The task itself is the learning process and the technology is only the medium. Jukes and McCain argue that learning about the technology is nothing but an "incidental but essential byproduct of the process" (43).

In order for students to become proficient with technology, technology must play a comprehensive role in the instructional process. In "Maximizing the Impact: The pivotal role of technology in a 21st century education system," The Partnership for Twenty-First Century Skills argues that you "cannot prepare students with the skills they need without making comprehensive use of technology throughout every aspect of education" (18). The Partnership argues that every other industry sector has realized the need for comprehensive technological proficiency and education needs to catch up, because "technology has a fundamental role to play in creating a 21st century education system" (18).

Based on the NETS, Jukes and McCain's definitions of technology proficiency and the Partnerships arguments on the need for comprehensive technological use in the classroom, the next guideline for twenty-first century technology use in instructional design is:

6. Technology use should be frequent, up-to-date and varied enough so that students have a second-nature ability to use it to perform tasks.

This last guideline is important in that it explains the need for non-technology-specific guidelines for twenty-first century technology use. Since the types of technology that are available are constantly changing and progressing, it would not be beneficial for students to focus on a skill set for any specific technology. By the time a student acquires a mastery of a tool, it may be obsolete. The skills acquired through technology use should be the skills to adapt to changing technologies and use new technologies effectively. These skills will be useful regardless of how technologies change.

In summary, I propose the following guidelines to help ensure that technology is effectively incorporated into instructional materials so students can be technologically fluent and have the twenty-first century skills to compete in a global world. The guidelines are as follows:

1. Technology use should foster creativity and design.
2. Technology use should enable communication and collaboration.
3. Technology use should allow students to gather, evaluate and use information.
4. Technology use should enable analysis as well as synthesis
5. Technology use should be guided but not limited by a set of safety policies
6. Technology use should be frequent, up-to-date and varied enough so that students have a second-nature ability to use it to perform tasks.

Using these guidelines will help educators design instructional materials that will meet the needs of twenty-first century students. The guidelines for twenty-first century technology use are designed to help instructional designers determine which technologies to incorporate into

instructional materials. They are intended to be applied to instructional design regardless of variables such as the context within which learning takes place, prior experience of the students, and the students' familiarity with the technologies. Since technology plays such a significant role in students' lives outside of the classroom, it is necessary technology also play a substantial role inside the classroom. Making the way students learn more like the way they live is the only way to bridge the digital divide and teach twenty-first students in a way that they understand. With frequent, effective use of technology in the classroom, students can learn the twenty-first century skills needed to compete in an increasingly digital and increasingly global environment. By applying these guidelines, instructional designers can help guide students to the use of technologies that will help develop these skills.

CHAPTER 5: CONCLUSION

Although this thesis specifically focuses on instructional design and technology use in twenty-first century education, it supports an overarching argument that education needs to be improved so students can learn the twenty-first century skills needed to compete in an increasingly digital and increasingly global environment. This argument has been embraced by decision makers and has recently become a national priority. In a presidential press conference on education given to the Joint Chiefs of Staff, President Barack Obama stated that “[in] a global economy where the most valuable skill you can sell is your knowledge, a good education is no longer just a pathway to opportunity – it is a pre-requisite. The countries that out-teach us today will out-compete us tomorrow (President Barack Obama, Feb. 24, 2009).

To address the need for a good education, the Obama administration has developed a platform for educational reform called “A World Class Education” (BarackObama.com). Under this platform, the administration plans to make K-12 math and science education a national priority. The Obama administration’s platform for educational reform reflects the fact that decision makers are embracing the need to improve education in the United States. This high level of support will help provide funding to make it possible to take much needed steps to effect change and improve education.

Funding Opportunities

Due to the current economic recession, state and local educational institutions are left with reduced funding for education. A decline in property values and property sales has caused

a decline in property taxes. Since our public school systems are funded primarily by property taxes, the schools are directly impacted. School boards have been forced to make reductions in resources and faculty. In this economic climate, arguments for improving education by incorporating new educational materials and more technology may seem unrealistic. However, the federal government has recognized that education should not suffer as a result of a faltering economy. The *American Recovery and Reinvestment Act (ARRA) of 2009*, also known as the “Stimulus Bill,” was signed into law by President Obama on February 17th, 2009. It is an “unprecedented effort to jumpstart our economy, create or save millions of jobs, and put a down payment on addressing long-neglected challenges so our country can thrive in the 21st century” (Ed.gov). The ARRA has made education for the 21st century one of the eight priorities for jumpstarting the economy.

The AARA targets investments in eight key areas that are intended to “create and preserve good jobs at the same time as it is strengthening the ability of this economy to become more efficient and produce more opportunities for employment” (Brost 2). The areas are: clean energy; science and technology, modernization of roads, bridges and waterways; tax cuts; lower healthcare costs; help for workers hurt by the economy; the protection of public sector jobs and vital services; and education for the twenty-first century. Under “Education for the 21st Century,” the AARA will “enable more children to learn in 21st century classrooms, labs and libraries to help our kids compete with any worker in the world” (Brost 3). The Committee on Appropriations for the ARRA projects that states will be tackling \$350 billion in budget shortfalls. The ARRA investments that are appropriated to K-12 education are intended to

“prevent cuts to critical education programs and services” (Brost 9). Included in the investments is \$14 billion for the renovation and modernization of K-12 school construction, which includes infrastructure technology upgrades. Also included in these investments is \$1 billion for educational technology. The investments appropriated for these infrastructure upgrades and educational technology will help facilitate the ability of schools to implement more technology into classroom instruction to ensure that classrooms are meeting the needs of twenty-first century students. With more funding for technology, schools will need more guidance on how to select the technologies that will be most effective for facilitating learning and developing twenty-first century skills. With the help of the guidelines that I propose, instructional designers will have more of an opportunity to negotiate their role in the process of developing a twenty-first century curriculum.

Discussions on developing a twenty-first century curriculum with additional learning materials and technologies are met with skepticism not only because of the current economic recession, but also because of concerns about equitable access. Decision makers are concerned that schools from lower-income areas will not have the same access to new learning materials and new technologies as schools from higher-income areas. If the ARRA funding is distributed evenly, in some lower-income areas the money will need to be allocated to more critical reparative needs rather than to improvement needs. For this reason, the ARRA also has additional funding opportunities that are specifically directed to lower income school districts.

The ARRA provides new funding for programs under *Title I, Part A of the Elementary and Secondary Education Act of 1965 (ESEA)* Specifically *Title I* provides funding for local school

districts that have “high concentrations of students from families that live in poverty” (Ed.gov) The purpose of this funding is to ensure that the students from lower-income school districts have the same opportunities to meet academic achievement standards as students in higher-income school districts. *Title I* provides \$10 billion in additional funds for these impoverished school districts. These funds create an opportunity for educators to “implement innovative strategies ... that improve education for at-risk students and close the achievement gaps while also stimulating the economy” (Ed.gov).

In addition to those appropriated under the ARRA, there are other funding opportunities specifically targeted for schools in lower-income school districts. The *21st-Century Community Learning Centers Program* administered under the Office of Elementary and Secondary Education (OESE) in the Department of Education provides grants to lower-income school districts for the creation of after-school learning facilities. The learning facilities are for K-12 students in lower-income school districts. The learning facilities are designed to offer these students after-school educational enrichment activities that complement their regular academic program. The funds for the learning centers may be used in a list of ways including innovative math and science education programs and telecommunications and technology education programs. These two areas specifically support the need for updating K-12 education to meet the needs of twenty-first century students. Students from lower-income school districts who do not have access to technology, may be able acquire that access at a *21st-Century Community Learning Center*.

Another program that is designed to improve equitable access to technology is the *Schools and Libraries Program of the Universal Service Fund*, also referred to as the "E-Rate," program. The E-Rate is administered by the Universal Service Administrative Company (USAC) under the direction of the Federal Communications Commission (FCC). It provides discounts to schools and libraries to assist them in obtaining affordable telecommunications and Internet access. Discounts are administered in a range from 20% - 90%. The discounts are determined based on the level of poverty of the district. In order to apply for the E-Rate discount, schools and libraries must create a technology plan. The plan needs to incorporate the following goals: a clear strategy for using the technology; a plan to ensure the staff knows how to use the technologies; an assessment of the technologies needed, including hardware, software and service; a proof of the budget to incorporate other elements in technology plan that are not discounted and a process for measuring the progress of the technology plan. Creating this technology plan may require schools and libraries to get outside help. The technology plan requirement may be another opportunity for instructional designers to demonstrate the value of their contribution to the curriculum design. With the help of the guidelines that I propose instructional designers will know which technologies are best to facilitate learning. Instructional designers will have the knowledge to make decisions about what technologies should be chosen for and implemented into an educational curriculum. In other words, the guidelines can be used to support the development of an E-Rate technology plan. The E-Rate also provides an additional opportunity for students in lower-income areas to find access to technologies needed to facilitate learning.

The funding sources presented provide opportunities for schools to implement innovative strategies for improving education. They also provide opportunities for schools to ensure increased and equitable access to technologies that facilitate learning. The funding sources also provide an opportunity for technical communicators. With funding for new innovative strategies and technology, technical communicators, with the assistance of the guidelines for twenty-first century instruction design and technology use that I propose, can position themselves as experts at implementing technologies into the curriculum as well as developing technology plans needed to apply for funding.

Contribution to the Field of Technical Communication

The guidelines that I propose for twenty-first century instructional design and technology use will provide additional discipline expertise for technical communicators. Technical communicators possess the rhetorical tools to design text with a specific audience in mind. These guidelines will help give them the knowledge base for one specific audience, twenty-first century students. By using the guidelines, technical communicators can create learning materials for students that are designed to assist the students in their mastery of the subject matter. In this role, technical communicators can position themselves as instructional designers, knowledge managers, information designers, and technology-integration specialists for twenty-first century instructional design.

Technical communicators are ideal candidates for instructional design because they possess a similar set of skills as instructional designers. Both disciplines require a user-centered

approach to documentation; instructional designers and technical communicators cannot create effective documents without having an understanding of the needs of the user. Saul Carliner discusses the similarities between technical communication and instructional design in “Different Names, Similar Challenges: What’s Behind the Rumored Merger of Instructional Design and Technical Communication.” In the article, Carliner explores how instructional designers and technical communicators have “moved onto similar paths” (1). The path has caused both to “re-define their work and seek new identities” (1). Technical communicators and instructional designers are working in each other’s fields. This transition, according to Carliner, is “bringing about a merger of the two fields” (1). Carliner argues that the merger is likely because both disciplines are in the adolescent stages and are continually re-defining themselves to adapt to changes in the environment. For example, changes such as the digitization of documents and learning materials required both disciplines to acquire the skills needed to create documents in a digital environment. To support his prognostication on the “evolutionary merger of the two fields” (1), Carliner compares the two by noting that instructional designers could not create effective learning materials without considering factors like resources and motivation. Similarly, technical communicators could not create effective documents without considering factors like poor product design. So, according to Carliner, the rhetorical approach to the creation of effective documents does not just make the two disciplines similar, it makes them the same. The guidelines that I propose provide technical communicators/ instructional designers the background to use rhetorical strategies to create effective documents for twenty-first century students.

The guidelines will also help technical communicators position themselves as information designers. The Society for Technical Communication defines information design as an “interdisciplinary approach combining skills in areas including graphic design, writing and editing, instructional design, human performance technology, and human factors” (STC.org). Graphic design and writing and editing are included in the basic skill set of most technical communicators, and the guidelines provide information on how a specific audience, twenty-first century students, interacts with information. In “Human Information Interaction,” Michael Albers argues that communication failure is caused by a “failure to understand how information is communicated to a person and how they interact with and interpret that information”(117). Albers argues that technical communicators “need to know what the reader is thinking, what they are looking to do, what they need, what is easy to understand, what is difficult to understand...”(119). Albers refers to the emphasis on how the reader interacts with the text as the “human-information interaction (HII)”(119). He states that “the technical communicator’s job has changed from creating a document to creating information appropriate for a communication situation...with highly dynamic information needs” (123). Albers argues that effective information design requires human-information interaction. The guidelines that I propose outline the human-information interaction of twenty-first century students to learning materials. The guidelines discuss how twenty-first century students interact with and interpret information. This is human-information knowledge that, according to Albers, is critical to effective technical communication. For this reason, the guidelines help technical communications create effective document for twenty-first century students.

The guidelines will also help technical communicators position themselves as knowledge managers by helping them take information and deliver it in way that creates knowledge for twenty-first century students. According to a report commissioned by the Department of Education, *A Generational Opportunity: A 21st Century Learning Content Delivery System*, the role of knowledge management in instructional design has been traditionally held by the textbook publishers. Textbook publishers have had “de-facto control over discipline-specific knowledge for instructional use” (2). According to the report, textbook publishers also have had control of the content delivery process and the procedures that are in place require “a textbook-like price to support their expensive comprehensive solution and high direct marketing costs” (3). This report suggests that the digital age is creating opportunities for changing how instructional materials are developed and delivered. They propose a need for an open marketplace for all instructional materials where “all content producers, technology companies, course and learning management systems [have] an equal opportunity to participate” (16). This approach helps to increase competition in the instructional materials market. It will also allow for the digital production and delivery of learning materials, which help decrease cost as well as environmental impact. The content in this marketplace will ideally be deliverable in many different formats so the choice can be made based on the technology that is available to the student. The open marketplace or learning content marketplace provides a great opportunity for technical communicators to create a niche for themselves as instructional designers. The increased competition that the open marketplace will create, presents an advantage for those with additional design expertise. These guidelines will help add

to that expertise. Reducing the control that the publishers have on the delivery of learning materials also provides an opportunity for those with subject matter expertise to contribute to the document delivery decision. These guidelines will help technical communicators build that expertise.

The guidelines also enable technical communicators to position themselves as technology-integration specialists. Technical communicators need to have strong technology skills in order to use and adapt to new technologies as they take on new projects. When technical communicators design instructional material using these guidelines as a reference, they will need to be cognizant of the technologies that are available to facilitate learning. They will need to consistently update their knowledge of available technologies and their uses. Having a vast knowledge of the technologies available will enable them to not only design learning materials that will effectively incorporate technologies into learning, but also advise educators as to what technologies could be implemented. This expertise will enable technical communicators to position themselves as technology-integration specialists; technical communicators can design the texts and act as consultants on the process of selecting technologies to integrate into the curriculum as well as the process of implementing technological components into the instructional design.

Areas of Future Research

As technology becomes more prevalent in the classroom, I argue that more research is needed on the benefits of the digitization of learning materials and how technical communicators can best position themselves as creators of digital learning materials.

The digital divide continues to narrow as digital natives grow older and become educators and decision makers; the educators, decision makers and teachers will soon all be digital natives. In the future we can expect the need to digitize our classrooms and learning materials will become more prevalent. Over ten years ago, Dr. Seymour Papert predicted what he called a “megachange in the way children learn” at the 11th Colin Cherry Memorial Lecture on Communication. He references an advertisement that suggested that computers play a supplemental role in the educational process. He suggests that on the contrary computers play a primary role in education. He asserts that technology represents the ultimate extinction of our current educational paradigm. He argues that the legislature is perpetuating the resistance to this "megachange." The real skill to acquire is the ability to learn and the ability to respond to changing circumstances effectively. Before we can change, we need to learn to embrace the idea of change. As Dr. Papert predicted ten years ago and as the current trend seems to support, technology is increasingly important to an effective twenty-first century education. Research needs to be done to determine if learning materials are more effective when they are delivered digitally.

In addition to facilitating learning, digital leaning materials may also reduce the costs of producing K-12 learning materials. There is little national research on the cost of K-12

textbooks. The Department of Education addresses the cost of college textbooks, but does not discuss the cost of K-12 textbooks. The report of the Advisory Committee on Student Financial Assistance, "Turn the Page: Making College Textbooks More Affordable," discusses how digital learning materials have clear positive implications for reducing textbook cost. The reason, according to the report, is that they "do not have publishing, printing, and inventory costs as high as traditional textbooks" (25). The report argues that implementing digital learning materials will be "increasingly convenient to ever-more technologically savvy students." Although this report focuses exclusively on college textbooks, this argument has made its way into discussion on a K-12 level.

The State of California has researched the cost-reduction benefits of digitizing learning materials. The California Open Source Textbook Project (COSTP) has been created to address "the high cost, content range, and consistent shortages of K-12 textbooks in California" (opensource-text.org). According to the project's website, California spends nearly \$400M annually for K-12 textbooks. As enrollments increase regularly on a K-12 level, it is expected that the cost of textbooks will continue to rise on a proportionate level. The proposed benefits of the COSTP are not simply to reduce the cost of textbooks; the benefits are also to increase the range of content, end textbook shortages and to create a content database that can easily adapt to changing technologies as they are introduced in the classroom (opensource-text.org).

An additional benefit of the digitization of learning materials is the potential reduction in environmental impact. While some digital learning materials will likely still be printed by the students and teachers for educational purposes, it is likely that there will be a reduction in the

paper and printing as digital natives tend to prefer to gather information from digital sources. With all of the potential benefits of the digitization of learning materials, facilitation of learning for digital natives, reduction in cost and reduction in environmental impact, it is likely that there will be a digitization of learning materials in the near future. For this reason, more research needs to be done on how technical communicators can best position themselves as experts in the creation of digital learning materials.

The guidelines that I propose will continue to be relevant as learning materials become increasingly digitized. They are designed specifically to be applied to any document format. Technical communicators/ instructional designers can use the guidelines that I propose for twenty-first century instructional design and technology use to help create effective learning materials that will meet the specific learning characteristics of twenty-first century students. The guidelines will help to bridge the gap between how students live outside of the classroom and how they learn inside the classroom. Bridging this gap is a critical step to motivating students to learn and preparing them to compete in an increasingly global economy.

APPENDIX: THESIS DEFENSE ANNOUNCEMENT

Announcing the Final Examination of Ms. Jennifer Gabriel for the degree of Master of Arts in English/ Technical Communication

Date: June 30th

Time: 1:30 p.m.

Room: CNH 407A

Thesis Title: Guidelines for Twenty-First Century Instructional Design and Technology Use: Technology's Influence on the Brain

My thesis discusses how constant exposure to technology has impacted learning for twenty-first century students. Neuroscientific findings and scientific studies show that constant exposure to technology has literally changed the brains of twenty-first century students. They learn differently from students of previous generations; however, they are being taught with instructional materials that were designed for previous generations.

I argue that the instructional design of educational materials fails to meet the needs of twenty-first century students, and their ability to achieve to their full potential is hindered as a result of this failure. I support this argument with research that suggests that K-12 U.S. students are graduating from high school unprepared to pursue degrees in science, technology, engineering and math (STEM) in college. Without STEM degrees they will be unable to pursue technology jobs after graduation. To support this argument, I provide statistics that show that the U.S. is failing to produce as many graduates in STEM as other countries.

In an increasingly global world, without graduates in STEM courses the U.S. is at risk of losing its position as the economic world leader. This argument is supported with research on globalization and the educational achievement of other countries.

This thesis argues that the instructional design of twenty-first century learning materials should be improved by adhering to guidelines for twenty-first century learning characteristics and twenty-first century technology use. The guidelines support a national goal to improve K-12 achievement in order to increase U.S. STEM graduates and increase the U.S.'s ability to compete in a global economy.

Outline of Study:

Technical Communication

Educational Career:

B.A., 1999, University of Central Florida

Committee in Charge:

Dr. Madelyn Flammia (Chair), Dr. Kathleen Bell, Dr. JD Applen

The public is welcome to attend.

WORKS CITED

Abrevaya, Sandra, and John McGrath. "\$44 Billion in Stimulus Funds Available to Drive Education Reforms and Save Teaching Jobs." Ed.gov April 1, 2009 2009.

Albers, Michael J. "Human Information Interaction." Proceedings of the 26th annual ACM international Conference on Design of ommunication (2008): 117-24.

Andrade, Javier, et al. "Guidelines for the Development of e-Learning Systems by Means of Proactive Questions." Computers & Education 51.4 (2008): 1510-22.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=aph&AN=33992600&site=ehost-live>>.

Asgari, M., and D. Kaufman. "Relationships among Computer Games, Fantasy, and Learning." International Conferences on Imagination and Education 2004 2nd International Conference Proceedings on Imagination in Education. Vancouver, BC, 2004.

Bacchus, Mohammed Kazim. "The Education Challenges Facing Small Nation States in the Increasingly Competitive Global Economy of the Twenty-First Century." Comparative Education 44.2 (2008): 127-45.

<<http://www.informaworld.com.ezproxy.lib.ucf.edu/openurl?genre=article&id=doi:10.1080/03050060802040953>; >

<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=eric&AN=EJ792253&site=ehost-live>>.

Bransford, John D., Ann L. Brown, and and Rodney R. Cocking. How People Learn: Brain, Mind, Experience, and School. Ed. Committee on Developments in the Science of Learning, National Research Council. Washington, D.C.: The National Academy Press, 1999.

"California Open Source Text Project (COSTP)." <<http://www.opensourcetext.org>>.

Carliner, Saul. "Different Names, Similar Challenges: What's Behind the Rumored Merger of Instructional Design and Technical Communication?" Performance Improvement 39.7 (2000): 5-8.

Cramer, Susan R. "Update Your Classroom with Learning Objects and Twenty-First-Century Skills." Clearing House 80.3; 3 (2007): 126-32.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=tfh&AN=24660524&site=ehost-live>>.

Dean, Katie. "Study: PDAs Good for Education." Wired 11.12.02 2002. April 21, 2008.

Delano, Richard K., and Katherine C. Hutton. "Economic and Workforce DEVELOPMENT - K THROUGH 12 EDUCATION ISSUE." Economic Development Journal 6.2 (2007): 47-53.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=aph&AN=25580152&site=ehost-live>>.

"Digital Tools for Digital Students." <<http://www.apple.com/education/digitalkids/>>.

Doidge, Norman. The Brain that Changes itself : Stories of Personal Triumph from the Frontiers of Brain Science. Carlton North, Vic: Scribe Publications, 2008.

Doughty, Venita Mertz. An Instructional Designer Learns about Technology Integration: Developmental Work Research in an Urban School. ProQuest Information & Learning, 2007
US

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=psych&AN=2007-99211-171&site=ehost-live>>.

Evans, Ellen, and Jeanne Po. "A Break in the Transaction: Examining Students' Responses to Digital Texts." Computers & Composition 24.1 (2007): 56-73.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=aph&AN=24249621&site=ehost-live>>.

Friedman, Thomas L. The World is Flat : A Brief History of the Twenty-First Century. 1st Picador ed., Further updated and expanded, [Pbk. ed. ed. New York: Picador/Farrar, Straus and Giroux : Distributed by Holtzbrinck Publishers, 2007.

Gee, John Paul. "Hire Score Education." Wired Magazine May 2003 2003

<<http://www.wired.com/wired/archive/11.05/view.html?pg=1>>.

Geraci, John C. "Learning from Youth Marketers: Adapting to the Schoolhouse what Business Already Knows about the Millennials." School Administrator 62.8 (2005)

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=eric&AN=EJ726615&site=ehost-live>>.

"Getting America's Students Ready for the 21st Century — Meeting the Technology Literacy Challenge, A Report to the Nation on Technology and Education, June 29, 1996." Ed.gov.

<<http://www.ed.gov/about/offices/list/os/technology/plan/national/index.html>>.

Hardaway, Don, and Richard P. Will. "Digital Multimedia Offers Key to Educational Reform." Communications of the ACM 40.4 (1997): 90-6.

International Society for Technology in Education. National Educational Technology Standards. Washington, D.C.: ISTE, 2007.

Ito, Mizuko, et al. Living and Learning with New Media: Summary of Findings from the Digital Youth Project. Cambridge, Massachusetts: The MIT Press, 2008.

James, Josh, and Jenna Leary. U.S. 4th and 8th Graders Need to Go Back to School Math Scores Improve Slightly but Remain Low; Science Scores are Stagnant. Vol. 26. Washington, D.C.: AeA, 2008.

Javidi, Giti, and Ehsan Sheybani. "Digispired: Digital Inspiration for Interactive Game Design and Programming." Journal of Computing Sciences in Colleges 24.3 (2009): 144-6.

Jensen, Eric. Teaching with the Brain in Mind. 2 ., rev. a updat ed. Alexandria, Va.: Association for Supervision and Curriculum Development, 2005. <Table of contents <http://www.loc.gov/catdir/toc/ecip057/2005002844.html>>.

Johns, Sara Kelly. AASL Standards for the Twenty-First-Century Learner: A Map for Student Learning. Vol. 36. American Library Association, 2008. <<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=tfh&AN=33061337&site=ehost-live>>.

Jukes, Ian, and Anita Dosaj. "Understanding Digital Kids (DKs); Teaching & Learning in the New Digital Landscape." (2004) .

Jukes, Ian, and Ted McCain. Understanding Digital Kids: Teaching & Learning in the New Digital Landscape. The InfoSavvy Group, 2008.

Kazmierczak, Matthew, and Josh James. Losing the Competitive Advantage? the Challenge for Science and Technology in the United States. Ed. William T. Archey. Washington, D.C.: AeA, 2005.

---. We are Still Losing the Competitive Advantage: Now is the Time to Act. Ed. William T. Archey. Washington, D.C.: AeA, 2007.

Kennedy, Tracy L. M., et al. Networked Families: Parents and Spouses are using the Internet and Cell Phones to Create a "new Connectedness" that Builds on Remote Connections and Shared Internet Experiences. Washington, D.C.: PEW INTERNET & AMERICAN LIFE PROJECT, 2008.

Kirkwood, Adrian, and Linda Price. "Learners and Learning in the Twenty-First Century: What do we Know about Students' Attitudes Towards and Experiences of Information and Communication Technologies that Will Help Us Design Courses?" Studies in Higher Education 30.3 (2005): 257-74.

<<http://taylorandfrancis.metapress.com.ezproxy.lib.ucf.edu/link.asp?target=contribution&id=M553063X96321155;>
<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=eric&AN=EJ691448&site=ehost-live>>.

Lenhart, Amanda, et al. Writing, Technology and Teens: Teens Write a Lot, but they do Not Think of their Emails, Instant and Text Messages as Writing. this Disconnect Matters because Teens Believe Good Writing is an Essential Skill for Success and that More Writing Instruction at School would Help them. Washington, D.C.: PEW INTERNET AND LIFE PROJECT, 2008.

---. Writing, Technology and Teens: Teens Write a Lot, but they do Not Think of their Emails, Instant and Text Messages as Writing. this Disconnect Matters because Teens Believe Good Writing is an Essential Skill for Success and that More Writing Instruction at School would Help them. Washington, D.C.: PEW INTERNET AND LIFE PROJECT, 2008.

Lenhart, Amanda, et al. Teens, Video Games, and Civics: Teens' Gaming Experiences are Diverse and Include Significant Social Interaction and Civic Engagement. Washington, D.C.: PEW INTERNET & AMERICAN LIFE PROJECT, 2008.

Lenhart, Amanda, et al. Teens and Social Media: The use of Social Media Gains a Greater Foothold in Teen Life as they Embrace the Conversational Nature of Interactive Online Media. Washington, D.C.: PEW INTERNET & AMERICAN LIFE PROJECT, 2007.

Lesh, Richard, Susan K. Byrne, and Pamela A. White. "Distance Learning: Beyond the Transmission of Information Toward the Coconstruction of Complex Conceptual Artifacts and Tools." Learner-Centered Theory and Practice in Distance Education: Cases from Higher Education. Ed. Thomas M. Duffy, et al. Mahwah, NJ US: Lawrence Erlbaum Associates Publishers, 2004. 261-281.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=psyh&AN=2003-88253-015&site=ehost-live>>.

Levin, Douglas, and Sousan Arafeh. The Digital Disconnect: The Widening Gap between Internet Savvy Students and their Schools. Washington, D.C.: The Pew Internet and American Life Project, 2002.

Macgill, Alexandra Rankin. Parent and Teenager Internet use. Washington, D.C.: PEW INTERNET AND AMERICAN LIFE PROJECT, 2007.

McElroy, Patrick, Joan Leonard, and Barry Beckerman. A GENERATIONAL OPPORTUNITY: A 21ST CENTURY LEARNING CONTENT DELIVERY SYSTEM. 2007 Learning Content Exchange, Inc., 2007.

McGlynn, Angela Provitiera. "Millennials in College: How do we Motivate them?" Education Digest: Essential Readings Condensed for Quick Review 73.6 (2008): 19-22.

<<http://www.eddigest.com/html/contentsmain.html>;

<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=eric&AN=EJ798989&site=ehost-live>>.

National Center for Education Statistics. Public Schools and Instructional Rooms with Internet

Access, by Selected School Characteristics: Selected Years, 1994 through 2005. U.S.

Department of Education Institute for Education Sciences, 2007.

<http://nces.ed.gov/programs/digest/d07/tables/dt07_413.asp?referrer=list>.

National School Board Association. Creating & Connecting: Research and Guidelines on Online

Social — and Educational — Networking. Ed. Voxley Lang. National School Board

Association, 2007.

"National Science Board Approves and Takes to Congress National Action Plan for Twenty-First

Century STEM Education." Technology Teacher 67.4; 4 (2008): 2-3.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=tfh&AN=27749094&site=ehost-live>>.

Nielsen, Jakob. "F-Shaped Pattern For Reading Web Content." Useit.com. April 17, 2006 2006.

<http://www.useit.com/alertbox/reading_pattern.html>.

Obama, Barack. Presidential Press Conference on Education., 2009.

Palfrey, John G., and Urs Gasser. Born Digital : Understanding the First Generation of Digital Natives. New York: Basic Books, 2008.

Papert, Dr Seymour. "Child Power: Keys to the New Learning of the Digital Century." 11th Colin Cherry Memorial Lecture on Communication (1998) .

Pink, Daniel. A Whole New Mind. 1st ed. Toronto: Riverhead Books, 2006.

Prensky, Marc. "Digital Natives, Digital Immigrants." On The Horizon 9.5 (2001).

---. "Digital Natives, Digital Immigrants, Part II: Do they *really* Think Differently?" On The Horizon 9.6 (2001) .

---. Don't Bother Me Mom—I'm Learning!: How Computer and Video Games are Preparing Your Kids for 21st Century Success and how You can Help!. 1st ed. Paragon House, 2006.

---. "Twitch Speed: Keeping Up With Young Workers". "marcprensky.com. January 1998 1998.
<<http://www.marcprensky.com/writing/Prensky%20-%20Twitch%20Speed.html>>.

Prensky, Marc. "Don't Bother Me Mom, I'm Learning!" : How Computer and Video Games are Preparing Your Kids for Twenty-First Century Success and how You can Help!. 1st ed. St. Paul, Minn: Paragon House, 2006.

<<http://www.loc.gov/catdir/toc/ecip063/2005032636.html>; Materials specified: Table of contents <http://www.loc.gov/catdir/toc/ecip063/2005032636.html>>.

---. "At Issue: Will Reading Remain a Vital Skill in the 21st Century? no." CQ Researcher 18.8 (2008): 185-.

<<http://ucfproxy.fcla.edu/login?URL=http://search.ebscohost.com.ucfproxy.fcla.edu/login.aspx?direct=true&db=aph&AN=31208891&site=ehost-live>>.

Richardson, W. Blogs, Wikis, Podcasts, and Other Powerful Web Tools for Classrooms. Thousand Oaks, Calif: Corwin Press, 2006.

<<http://www.loc.gov/catdir/toc/ecip063/2005033579.html>; Materials specified: Table of contents only <http://www.loc.gov/catdir/toc/ecip063/2005033579.html>; Materials specified: Publisher description

<http://www.loc.gov/catdir/enhancements/fy0661/2005033579-d.html>>.

Richardson, Will. Blogs, Wikis, Podcasts, and Other Powerful Web Tools for Classrooms.

Thousand Oaks, Calif.: Corwin Press, 2006. <Publisher description

<http://www.loc.gov/catdir/enhancements/fy0661/2005033579-d.html>; Table of contents

only <http://www.loc.gov/catdir/toc/ecip063/2005033579.html>; Table of contents

<http://www.loc.gov/catdir/toc/ecip063/2005033579.html>>.

Robertson, Judy, and Judith Good. "Children's Narrative Development through Computer Game Authoring." TechTrends: Linking Research & Practice to Improve Learning 49.5 (2005): 43-59.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=aph&AN=19511593&site=ehost-live>>.

Rochelson, Dave. "'The search for knowledge, truth and a greater understanding of the world around us'." Change.gov. December 20th 2008 2008.

<http://change.gov/newsroom/entry/the_search_for_knowledge_truth_and_a_greater_understanding_of_the_world_around_us/>.

Rutherford, Rebecca H., and James K. Rutherford. "Universal Instructional Design for Learning how to Apply in a Virtual World." Destin, FL, .

"Science, Technology and Innovation for a New Generation." Organizing for America.

<<http://www.barackobama.com/issues/technology/>>.

Shane, Harold G. "Improving Education for the Twenty-First Century." Education Digest 56.8; 8 (1991): 12-4.

<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=tfh&AN=9106101383&site=ehost-live>>.

Shelly, Gary B., et al. Teachers Discovering Computers; Integrating Technology and Digital Media in the Classroom. Fifth ed. Boston: Thompson Course Technology, 2008.

Small, Gary W., and Gigi Vorgan. IBrain : Surviving the Technological Alteration of the Modern Mind. 1st ed. New York: Collins Living, 2008.

"Society for Technical Communication." <stc.org>.

Squire, Kurt, and Constance Steinkuehler. "MEET THE GAMERS. (Cover Story)." Library Journal 130.7; 4 (2005): 38.
<<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=ulh&AN=16770715&site=ehost-live>>.

Tapscott, Don. "Growing Up Digital." 2008.

The Partnership for 21st Century Skills Taskforce. Learning for the 21st Century; A Report and Mile Guide for 21st Century Skills. The Partnership for 21st Century Skills, 2002.

---. Maximizing the Impact: The Pivotal Role of Technology in a 21st Century Education System. ISTE.org; SETDA, 2007.

United States Government. America Competes Act. Trans. 110th Congress. Vol. 110-69., 2007.

Warlick, David. "Textbooks of the Future: It's Time the Textbook Industry Redefined what they do and how they do it." Technology & Learning 24.10 (2004)

<<http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ703719&site=ehost-live>>.

"A World Class Education." <<http://origin.barackobama.com/issues/education/>>.

Wurman, Richard Saul, et al. Information Anxiety II. Ed. Karen Whitehouse. 2nd ed. New York: Pearson Education, 2000.

Yelland, Nicola, Bill Cope, and Mary Kalantzis. "Learning by Design: Creating Pedagogical

Frameworks for Knowledge Building in the Twenty-First Century." Asia-Pacific Journal of Teacher Education 36.3 (2008): 197-213.

<<http://www.informaworld.com.ezproxy.lib.ucf.edu/openurl?genre=article&id=doi:10.1080/13598660802232597>;
<http://search.ebscohost.com.ezproxy.lib.ucf.edu/login.aspx?direct=true&db=eric&AN=EJ804250&site=ehost-live>>.