

The Writing Process and Technology in the Fourth Grade

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**Abstract**

To understand the use of technology in fourth grade writing process instruction, current literature on the writing process, the use of technology in education, and current education standards were all examined. While there is much research to support the use of the computer and word processor in teaching fourth graders to plan, compose and revise their writing; integration has not occurred at the anticipated rate. The analysis of the incorporation of technology in the writing process provided the context in which to consider the inhibitors that have kept teachers from integrating technology into their lessons; and the impact the computer has had on public education over the last three decades.

### The Writing Process and Technology in the Fourth Grade

While some famous authors, including J.K. Rowling, have written all their books by hand, the writing process has evolved to include the computer and word processor (Florey, 2009). “Keyboarding is the penmanship of the computer age. Just as skill with a pen fosters the ability to communicate in writing, keyboarding extends that ability into the area of word processing, electronic communication, and desktop publishing” (Johnson, Nelson, & Townsend, 2002, para. 2). How should elementary school students, specifically those in the fourth grade, learn to compose and write? Should these students be composing and editing drafts using paper and pencil, computer and word processor, or some mix of the two? The question driving this research is: how is technology incorporated into the writing process as it is taught to fourth grade students?

In 2009 as a pre-service teacher in one of the top school districts in the country, I observed many fourth grade students still using the “hunt and peck” typing method on the computer during writing process instruction. Students frequently lost their train of thought hunting for a certain key, which significantly impacted the effectiveness of the writing composition exercise. This observation sparked my interest in the use of technology when teaching writing in the primary grades. I wanted to know what the standards required, the curriculum included, and the latest research has discovered. Student access to computers has gone from a ratio of 125:1 in 1984, to under 5:1 in 2003 (Cuban & Cuban, 2007). In the early 1990’s my children’s teachers told me that research recommended waiting until middle school to teach keyboarding because students hands were too small, and they were not developmentally ready to learn this skill in the primary grades. Zeitz (2008) now recommends teaching keyboarding in lower primary grades when students start using computers.

The standards and benchmarks are the starting point, the guide to understanding what components and skills should be taught in Language Arts, including the writing process (Cooper & Kiger, 2009). K-12 education standards exist at international, national, and state levels. The international and national standards set the direction; each state's standards define what is to be implemented in the curriculum. In the last two decades, organizations that define standards have recognized the need to incorporate technology into most standards including Language Arts. Both the Common Core State Standards Initiative (2010a), and the National Council of Teachers of English (1996) have incorporated the use of software tools in the writing process. The objective of the Partnership for 21st Century Skills (2009) is to assist states in incorporating technology into the state standards by providing frameworks and skill maps. New Mexico only recently adopted the Common Core State Standards Initiative, and has not yet taken a position on the Partnership for 21st Century Skills framework; however the primary grade state standards for Language Arts include using technology in the writing process (New Mexico Public Education Department, 2009).

A process is a collection of activities or procedures organized in a logical order, using a variety of skills to accomplish a complex objective (Marzano, Pickering, & Pollock 2001). A process is more abstract and broader than a procedure and while it may require many varied skills, it is more complex than any one skill. It is considered a metacognitive activity, one that includes awareness of the steps, and activities to achieve the end product. Olson (as cited in Englert, Manalo & Zhao, 2004) considers writing a process, as it is an abstract task with the goal of using a second order symbolic system, writing, to communicate with a remote audience. He further recognizes that to achieve the ability to create the end product that fulfills the author's goal requires the acquisition of multiple skills and capabilities. The writing process is

unpredictable, frequently includes recursion and looping, that is procedures imbedded within themselves, and procedures repeated over and over (Marzano et al., 2001; Lannon, 2009). The writing process, as defined by Marzano et al. (2001), includes three main steps: prewriting, writing, and revising, with each step having subcomponents.

“Writing is not merely a school-based practice but a lifelong skill used to accomplish specific goals and convey particular messages within community and workplace settings” (National Association of Educational Progress, 2010, Introduction Section para. 4). This research describes the history of the writing process, technology included in writing process activities, and the prerequisite skills students need to use these tools. Basic technology instruction, including keyboarding, menu navigation, and overall system operation are prerequisites to incorporating software tools into writing process instruction (Bauer & Kenton, 2005). “Appropriate placement of keyboarding instruction in the elementary curriculum and reinforcement throughout their school years can provide the necessary foundation for the rest of our students’ lives” (Zeitz, 2008, Executive Summary Section, para. 1).

The term *technology* has taken on many different meanings over time. It describes how people change or modify their environment to extend their abilities, wants, and needs (Dugger, 2001). Our great grandparents considered electricity and automobiles technology, adults think of computers and the Internet as technology; but children today, who have never known life without the Internet, view eBooks and iPads as technology, computers and the Internet are just infrastructure. The International Society for Technology in Education (ISTE) consistently uses the term *Information and Communication Technology (ICT)* in place of the term technology, as it is more specific and a better description of the domain (ISTE, 2007). Many research papers

include computers and computer software within the scope of technology or ICT. This paper follows these conventions.

The term *keyboarding* is used in this paper to describe *touch typing* on a computer keyboard. This is consistent with terminology used in education standards. According to Florey (2009) the term *keyboarding* originated in the 1960's when keypunch operators typed on a QWERTY keyboard to load punch cards with data that could then be read by a computer. "Condensing *typing on a keyboard* to just plain *keyboarding* has a high-tech ring to it" (Florey, 2009).

This paper investigates the question, how is technology incorporated into the writing process as it is taught to fourth grade students? It includes current information and research on these questions:

- How have English Language Arts, Computer Literacy, and Technology Standards converged to describe the writing process standards for fourth grade students?
- How does current research describe the writing process phases, steps, and activities?
- How is technology incorporated into the writing process at the fourth grade level?
- To master the writing process at the fourth grade level, what technical skills and computer literacy knowledge do students need and how should these skills be taught?

### **What Does the Literature Say?**

The literature review is divided into four sections: the development of technology standards, and their integration into the English Language Arts standards; the development of the

writing process; the integration of technology into the writing process; and the ICT knowledge and skills required when technology is integrated into the writing process.

### **The Standards: English Language Arts, and Technology**

The 1983 report: *A Nation at Risk: The Imperative for Educational Reform* published by the U.S. Department of Education's National Commission on Excellence in Education included a key recommendation: "that schools, colleges, and universities adopt more rigorous and measurable standards" (National Commission on Excellence in Education, 1983, Recommendation B: Standards and Expectations Section, para. 1). This recommendation started the standards movement. Over the next three and a half decades several different organizations defined standards at the international, national, and state levels. During this time period the personal computer and Internet were evolving. These organizations recognized the technological evolution was changing the skills required in core subject areas and included ICT in their standards definitions. This section reviews the literature to answer the question, how have English Language Arts, computer literacy, and technology standards converged to describe the writing process standards for fourth grade students?

Standards organizations at the international and national level, national teacher organizations, and the US Department of Education all provide input to state public education departments, which define the education standards and performance benchmarks for their public schools. Focusing on English Language Arts, as shown in Table 1 with their mission statements, the main organizations currently providing input to the states are: the National Council of Teachers of English (NCTE), the Common Core State Standards Initiative (CCSSI), the International Society for Technology in Education (ISTE) and the Partnership for 21<sup>st</sup> Century Skills (P21).

Table 1

*Standards Organizations Providing Input to State Education Departments*

Acronym	Name	Mission
NCTE	National Council of Teachers of English	“...improving the teaching and learning of English and the language arts at all levels of education” <sup>a</sup>
CCSSI	Common Core State Standards Initiative	“...provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them...” <sup>b</sup>
ISTE	International Society for Technology in Education	“...improve learning, teaching, and education administration through appropriate uses of technology.” <sup>c</sup>
P21	Partnership for 21st Century Skills	“To serve as a catalyst to position 21st century readiness at the center of U.S. K12 education by building collaborative partnerships among education, business, community and government leaders.” <sup>d</sup>
NAEP	National Assessment of Educational Progress	“...is a continuing and nationally representative measure of trends in academic achievement of U.S. elementary and secondary students in various subjects” <sup>e</sup>
NMPED	New Mexico Public Education Department	“To provide leadership, technical assistance and quality assurance to improve student performance and close the achievement gap” <sup>f</sup>

Note. CCSSO = Council of Chief State School Officers.

<sup>a</sup>National Council of Teachers of English, (2008, Aug. 26). Retrieved n.d., from <http://www.ncte.org/mission>

<sup>b</sup>Common Core State Standards Initiative, (2011). Retrieved n.d., from <http://www.corestandards.org>

<sup>c</sup>International Society for Technology in Education, (2011). Retrieved n.d., from <http://tsi.iste.org/about/supporters>

<sup>d</sup>Partnership for 21st Century Skills, (2004). Retrieved n.d., from [http://www.p21.org/index.php?option=com\\_content&task=view&id=188&Itemid=110](http://www.p21.org/index.php?option=com_content&task=view&id=188&Itemid=110)

<sup>e</sup>National Association of Educational Progress, (2010, Sept.). In Writing Framework for the 2011 National Assessment of Educational Progress. Retrieved Jan. 19, 2011, from <http://nces.ed.gov/transfer.asp?location=www.nagb.org/publications/frameworks/writing-2011.pdf>, p. 2

<sup>f</sup>New Mexico Public Education Department,. N.p.: <http://www.ped.state.nm.us>, n.d

The NCTE, in addition to defining their own standards, has provided feedback and input to the ISTE, P21, and CCSSI standards organizations. The Council of Chief State School

Officers (CCSSO) formed the CCSSI to define English Language Arts knowledge and skills students should acquire in a K-12 education. The CCSSI chose to integrate twenty-first century skills recognizing that these skills are required across disciplines. “As specified by CCSSO and NGA [National Governors Association], the [Common Core State] Standards are (1) research and evidence based, (2) aligned with college and work expectations, (3) rigorous, and (4) internationally benchmarked” (Common Core State Standards Initiative, 2010a, p.3). Forty states have adopted the Common Core State Standards and are in the process of updating state standards to align and incorporate them (Common Core State Standards Initiative, 2010b).

P21 was formed in 2002 and provides framework definitions and skill maps for core subjects including English Language Arts. In conjunction with the NCTE, P21 updated its English skill map that illustrates the intersection between Language Arts and 21<sup>st</sup> Century Skills (Partnership for 21<sup>st</sup> Century Skills, 2008). There are fifteen P21 Leadership States that provide input on standards and assessments (Partnership for 21st Century Skills. 2004).

The ISTE, formed in 1989, has published National Education Technology Standards (NETS) for students (NETS\*S), teachers (NETS\*T), and administrators (NETS\*A). Research done by Niederhauser and Lindstrom (2006) on the application of NETS\*S in the classroom indicate some teachers are moving from drill and practice uses of technology to more tool based uses.

In *The Global Achievement Gap* Tony Wagner (2008) connects the world of work with the world of education. In the research described in this book, he identifies and explores in detail the gap between what is now being taught in good schools and what employers and colleges expect high school graduates to know. He describes these as the Seven Survival Skills. As

Table 2 shows, these skills are very similar to both the P21 Learning and Innovation Skills and the ISTE NETS\*S.

Table 2

*Technology Skills Comparison*

Wagner - Survival Skills <sup>a</sup>	ISTE NETS*S <sup>b</sup>	P21 Framework Definitions - Skills <sup>c</sup>
Critical Thinking and Problem Solving	Critical Thinking, Problem Solving, and Decision Making	Critical Thinking and Problem Solving
Collaboration Across Networks and Leading by Influence Effective Oral and Written Communication	Communication and Collaboration	Communication and Collaboration
Accessing and Analyzing Information	Research and Information Fluency	Information Media and Technology Skills
Curiosity and Imagination Initiative and Entrepreneurialism	Creativity and Innovation	Creativity and Innovation
Agility and Adaptability	Technology Operations and Concepts Digital Citizenship	ICT Literacy

*Notes.* ISTE = International Society for Technology in Education; NETS\*S = National Educational Technology Standards for Students; P21 = Partnership for 21<sup>st</sup> Century Skills; ICT = Information Communication and Technology.

<sup>a</sup>Wagner, T. (2008). The Global Achievement Gap. *In The New World of Work and the Seven Survival Skills* (p. 1-42) New York, NY: Basic Books Perseus Books Group.

<sup>b</sup>International Society for Technology in Education, (2007). *National Educational Technology Standards for Students, Second Edition*. Washington, DC: International Society for Technology in Education. p. 8.

<sup>c</sup>Partnership for 21st Century Skills, (2009). *In The MILE Guide: Milestones for Improving Learning & Education*. Retrieved Jan. 3, 2011, from [http://p21.org/documents/MILE\\_Guide\\_091101.pdf](http://p21.org/documents/MILE_Guide_091101.pdf) p. 8

The NCTE and CCSSI standards covering technology and the fourth grade writing process are organized by subject and grade level, while the P21 Frameworks and skills address the subject from the technology point of view. Some states, including New Mexico, incorporate

technology into their subject and grade level standards, while others address technology in a separate section.

The fourth grade writing standards in the English Language Arts Common Core State Standards include “with some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting” (CCSSI, 2010a, p. 21). While there is no mention of using software when revising writing or the use of digital graphic organizer tools, the standards do not preclude their use.

The NCTE standards take a less specific approach with a simple but inclusive set of twelve short statements for K-12 Language Arts standards. Number eight addresses technology in very broad terms: “Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge” (National Council of Teachers of English, 1996, p. 28). The document includes a section elaborating on the standard, noting the student motivation to use technology, the advantages of editing and revising online, and the enthusiasm for publishing and sharing written work. The keyboarding and word processing skills required are specified, and their development is encouraged.

Table 3 shows the standards and performance benchmarks that address technology and the fourth grade writing process for each of the standards organizations.

Table 3

*Standards Relating to Technology and the Writing Process in the fourth Grade*

Organization / Document	Standard
NCTE Standards for the English Language Arts	8. Students use a variety of technological and informational resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge. <sup>a</sup>
CCSSI Common Core State Standards For English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects	6. With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting. <sup>b</sup>
ISTE National Educational Technology Standards for Students	Grades 3 - 5 Performance Indicators: 1. Use keyboards and other common input and output devices efficiently and effectively. 4. Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum. 5. Use technology tools (e.g., multimedia authoring, presentation, Web tools, digital cameras, scanners) for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom. <sup>c</sup>
P21 21st Century Skills Map - English	Using digital technology, communication tools and/or networks appropriately to access, manage, integrate, evaluate, and create information in order to function in a knowledge economy 4 <sup>th</sup> Grade Outcome: Use technology as a tool to research, organize, evaluate and communicate information. <sup>d</sup>
NMPED Language Arts Grades K-4	K-4 Benchmark II-C: Demonstrate competence in the skills and strategies of the writing process. Technology found in Grade 2 and 3 Performance Standards for this Strand: Grade 2: Produce a variety of types of composition (e.g., stories, reports, correspondence) using media and technology to enhance the presentation/narrative for an audience for a specific purpose. Grade 3: Combine information from multiple sources, using technology as a tool in writing reports and stories. <sup>e</sup>

*Notes:* NCTE = National Council of Teachers of English; CCSSI = Common Core State Standards Initiative; ISTE = International Society for Technology in Education; P21 = Partnership for 21<sup>st</sup> Century Skills; NMPED = New Mexico Public Education Department.

<sup>a</sup>National Council of Teachers of English., (1996). In *Standards for the English Language Arts.* (chap. Chapter 3: The English Language Arts Standards). Retrieved Jan. 3, 2011, from <http://www.ncte.org/library/NCTEFiles/Resources/Books/Sample/StandardsDoc.pdf> p. 28

<sup>b</sup>Common Core State Standards Initiative. (2010a, June 2). *Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects*. Retrieved Jan. 2, 2011, from <http://corestandards.org/> p. 21

<sup>c</sup>International Society for Technology in Education, (n.d.). In *ISTE National Educational Technology Standards for Students (NETS\*S)*. Retrieved Jan. 27, 2011, from [http://cnets.iste.org/students/s\\_profiles.html](http://cnets.iste.org/students/s_profiles.html) p.2

<sup>d</sup>Partnership for 21st Century Skills, (2008, Nov.). In *21st Century Skills English Map*. (chap. ICT Literacy). Retrieved Jan. 3, 2011, from [http://p21.org/documents/21st\\_century\\_skills\\_english\\_map](http://p21.org/documents/21st_century_skills_english_map) p. 11

<sup>e</sup>New Mexico Public Education Department, (2009, June). In *Language Arts Grades K-4*. (chap. Strand II: Writing and speaking for expression.). Retrieved Jan. 3, 2011, from <http://www.ped.state.nm.us/standards/LanguageArts/LanguageArtsK-4.pdf>

### **The Writing Process: History and Components**

The writing process is well summarized by Goldstein and Carr: “‘process writing’ refers to a broad range of strategies that include pre-writing activities, such as defining audience, using a variety of resources, planning the writing, as well as drafting and revision. These activities collectively referred to as ‘process-oriented instruction’, approach writing as problem solving” (Goldstein & Carr, 1996, What Is Process Writing Section, para.1). Before considering the incorporation of technology into the writing process, the question, how does current research describe the writing process phases, steps, and activities, is investigated.

The writing process developed during the twentieth century as a way to facilitate teaching writing beyond simple direct instruction, changing the view of writing from product to process (Montague, 1990). This concept of writing as a process was validated in 1992 when the NCTE included the writing process in its fifth standard: “students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes” (National Council of Teachers of English, 1996, p. 25).

As early as 1965, Rohman (as cited in Pritchard & Honeycutt, 2006) recognized writing as a process that included three stages: prewriting, writing and rewriting. The writing process is now defined to include five main activities: prewriting, writing, revising, editing, and publishing. Editing was originally included in the revising activity, which was then decomposed into

revising for logic and flow, and revising for grammar, clearly separating revising from editing (Marzano et al., 2001; Cooper & Kiger, 2009). The final step to be included, considered an important component by Cooper and Kiger (2009), is publishing, which provides authentic feedback beyond the teacher's grade, to the student author.

Flower and Hays (1981) describe the planning or prewriting stage, as being very broad, revisited frequently during the following stages, with activities that include:

- building an internal framework of the knowledge represented mentally as a model or network, visually as briefly as a single keyword;
- retrieving, organizing, and categorizing information in long term memory, often leading to discovery and creative new ideas;
- setting goals that drive the motivation, and provide the energy to convey and express the ideas through the remaining stages.

Montague (1990) stressed the importance of utilizing the plan developed during prewriting in later stages, particularly referencing it during the revision step and possibly creating a second plan as part of the revision process.

The various activities in the writing process are nonlinear, recursive, and complex. When exercised by experts, they are used as needed, more as tools in a toolkit than sequenced steps in a procedure (Pritchard & Honeycutt, 2006). The Writing Study Group of the NCTE Executive Committee (2004) in the NCTE Beliefs About the Teaching of Writing clearly states that while writing is a process, it cannot be turned into a set of steps, or formula, and that the process strategies and skills are not accumulated all at once but learned over time.

The writing process can be considered a cognitive process, a social process, and a physical process, requiring the integration of declarative, substantive, and procedural knowledge

(Montague, 1990). The writing process must support a wide variety of purposes from developing social networks, to professional and academic communications (Writing Study Group of the NCTE Executive Committee, 2004). Both Lannon (2009) and Montague (1990) view writing as a decision process in problem solving that requires critical thinking in the planning, drafting, and revising stages.

With the advances in cognitive science, writing researchers include the development of schemata in components of the writing process (Anderson, 1977). During the same period that the writing process was evolving, Hirsch (1996) was developing a schema and rule based theory for the functional masteries, once the development of real world language skills has been achieved. He schematizes these complex functional masteries into 3 aspects:

- 1) mastery of the continually repeated formal elements of language to the point of automaticity, 2) the gaining of a content-rich knowledge base represented by particular word meaning and cultural conventions, and 3) the successful active deployment of these elements in comprehension and problem solving (Hirsch, 1996, p. 150).

He maintains that these patterns hold for handwriting and composition, in addition to speaking, listening, and reading – “where a great deal of effort is required to habituate the learner to the continually repeated formal elements of making letters and words so the level-one letter formation becomes sufficiently automatic so as not to interfere with the conscious deployment of written words to convey meaning” (Hirsch, 1996, p 150).

When learning a process, the parts should be practiced in the context of the whole with a view of the end products. In the context of the writing process, practicing the parts includes: structuring tasks to emphasize specific parts; identifying the parts which are skills and using drill where appropriate; considering some parts which flow naturally such as free writing and

providing opportunities to experiment; considering the end product, which is some form of publishing providing authentic feedback to the author (Marzano et al., 2001). The Common Core State Standards introduce writing in kindergarten, but wait until third grade to introduce the planning, and revising steps of the writing process, and to emphasize the editing element (CCSSI, 2010a). This is consistent with Hirsh's (1996) observation that one difference between experts and novices is that experts self-consciously monitor and evaluate some of their mental strategies. Hirsh also observed that rule automation, the automatic execution of a procedure without having to think about it, requires extensive practice; while schema acquisition, organization of knowledge that supports making sense of new knowledge, can be mastered fairly quickly.

Cooper and Kiger (2009) describe the stages of literacy development as broad definitions that include a wide range of overlapping and interrelated skills. Between first and third grade, students reach the beginning stages of reading and writing, starting to read in conventional ways, mastering pronunciation, developing fluency in reading, broadening vocabulary, developing automaticity in handwriting, and spelling. During fourth and fifth grade students will move into the almost fluent reading and writing stage. They are reading silently more than previous stages, have developed a larger vocabulary, and are doing more writing.

Strong emphasis on metacognitive instruction may not work for children who have not developed automaticity in the underlying skills. According to Siegler (as cited in Hirsch, 1996), this type of instruction can overload working memory and affect development of problem solving strategies. Recall the trick of asking someone a metacognitive question about their bowling style, such as "Do you exhale when releasing the ball?" just before their turn. It is much more difficult for the novice to work at the metacognitive level than the expert. Mastering the

base skills of letter formation, spelling, and transferring words from thoughts to paper, while maintaining the story line and flow of words in short term memory is a lot to ask of a student. In the primary grades the teacher must scaffold the writing process steps, alleviating the metacognitive stress for those students still working on skill automaticity, supporting a “gradual internalization of routines and procedures available to the learner from the social and cultural context in which the learning takes place” (Applebee, 1986, p. 108). As automaticity is developed in underlying skills and procedures, the writer is able to focus on the more difficult aspects of writing such as consistency of style, and clarity in expression of ideas (Montague, 1990).

### **The Role of Technology In the Writing Process**

The 2011 National Association of Educational Progress (NAEP) Writing Assessment for eighth and eleventh grades will be administered and require composition on the computer, eight years later this assessment will most likely require fourth grade students to compose on the computer (NAEP, 2010). This section considers the question, how technology is incorporated into the writing process phases, steps and activities at the fourth grade level?

The NCTE in its’ 2004 position statement *NCTE Beliefs about the Teaching of Writing* recognizes that teachers must support student self-sponsored writing outside of the classroom, including technology based writing such as emailing, instant messaging, texting, making Web sites, and blogging. Teachers need to understand “how writers use tools, including word-processing and design software and computer based resources” (Writing Study Group of the NCTE Executive Committee, 2004, *Writing is a Process*, para. 6) and share this knowledge with their students. The conventions readers expect when writing is published must be met, particularly in the context of technology, with the speed and distribution capability of the

Internet. These conventions include the 160-character text message or tweet, the daily blog or podcast, the wiki or web page, and the report, article, or user guide. Writing is no longer about just putting pen to paper, composing now happens in many different environments. Students cannot wait until college to be introduced to these new modes, methods, and concepts.

In 2001, Dugger wrote that our world will be very different in 10 or 20 years; we have a choice to either remain ignorant and helpless, letting it push us along, or decide for ourselves with our eyes open how we want it to be. Ten years ago wireless networks were just becoming common, Google had been a company for three years, and Facebook would not exist until 2004. However the word processing software used today such as Microsoft Word, AppleWorks, and WordPerfect have all been in common use since the 1980's. The word processor is the most common tool used in the writing process. The features that have been added over the years, from spelling and grammar support, to formatting and publishing, have made it an appropriate tool for most activities in the writing process.

As early as 1980 Papert saw the potential of using the computer as a writing instrument. He recognized the iterative nature of composition, creating an unacceptable first draft followed by multiple revisions. He knew that children find rewriting such a laborious task, that whenever possible the first draft becomes the final draft. However when children can use a computer to create their text, it is immediately displayed, easy to read and revise. When writing with pencil and paper, Papert recognized that the "skill of rereading with a critical eye is never [totally] acquired"; however "a child can move from total rejection of writing to an intense involvement (accompanied by rapid improvement of quality) within a few weeks of beginning to write with a computer" (p. 30). Papert saw the educator as an anthropologist trying to understand, identify, and predict the cultural materials relevant to intellectual development. He saw that changes were

coming as people started using the computer both at home and at work. This drove his development of an educational software program, Logo Turtle Graphics, in the 1960s. Versions of this software are still available today on computers and now even on the iPad.

Through the use of the TELE-Web software application which can be described as an interactive worksheet providing prompts and immediate feedback to the student, Englert et al. (2004), determined that technology could be used to scaffold the writing process in three areas:

- identify and highlight text structure or sequence of steps,
- support communication by stretching coordination of writing processes and structures among participants,
- present prompts and scaffolds that serve as thinking or mediating devices.

The use of prompts is consistent with the research Daiute did in 1987, incorporating a prompting program into his comparison study of revising on a computer versus pencil and paper. Just as calculators scaffold mathematics, the computer supports the writing process by facilitating organization, making text generation and revision physically easier and faster, offloading mechanical effort such as dictionary searches, and even reading (through speech synthesis) for review and revision (Englert, Wu & Zhao, 2005; Montague, 1990).

In the last three decades, over two hundred studies have been done on the effect of technology, specifically word processing, on the writing process. The results of these studies have consistently found students write more when using a word processor; however the results for quality of writing varied widely. These studies have also found that using the word processor improves students' attitudes toward the writing process, increases the number and quality of revisions, and increases overall productivity. During this period the word processing technology changed significantly from text based, green monochrome displays with command driven

systems, to the bit mapped image color displays, with menu and mouse driven systems that we use today. Many of the studies did not factor in the equivalent skill with keyboard and computer to paper and pencil, which students must acquire and noted this as having potential impact on results (Dalton & Hannafin, 1987; Dunn & Reay, 1989; Goldberg, Russell, & Cook, 2003; Grejda & Hannafin, 1992). In a one-to-one laptop program study for fourth grade students lasting two years the positive effect, measuring English Language Arts test scores, was greater in the second year, again validating the skill factor in these studies (Suhr, Hernandez, Grimes & Warschauer, 2010).

Goldberg et al. (2003), using meta-analytic techniques developed for the fields of economics and medicine, analyzed studies between 1992 and 2002 investigating the affect of computers on student writing. They found that using word processors had a positive effect on both the quality and quantity of writing, and “that the writing process is more collaborative, iterative, and social” (p. 2).

Both Gabriel and van Leeuwen (2007), and Moore-Hart (2005) found that when word processors are used as writing tools there are changes in the classroom, the environment becomes more collaborative, and communication patterns between students change. The computer monitor displays students writing neatly, clearly, easy to read, facilitating both student and teacher interaction in the context of the writing process. Gabriel and van Leeuwen found that writing instruction changed; there was more student interaction and learning by discovery, creating strong linkages. For example, one student finally understood what quotes are and how to use the shift key with direction from the teacher and assistance from a classmate. Seeing his neatly quoted dialogue on the screen inspired him to create even more dialogue. By

experimenting, discovering for themselves, and sharing their expertise, students develop their problem solving skills and confidence in their ability to learn.

There is some concern that writing exclusively with a word processor will impact the ability to write with pencil and paper. Grejda and Haanafin (1992) designed their research to test skill transference by including a combined group using both writing methods. They found that “intermittent word processing neither improved nor impeded transfer to paper-and-pencil formats” (p. 148).

Table 4 shows ways that a word processor and the Internet can be used in each stage of the writing process. The table uses MSWord and Firefox as examples but most Word Processing and Web Browsing tools have equivalent capabilities.

Table 4

*Technology in the Writing Process*

	Word Processor - MSWord	Internet - Firefox
Prewriting	Outlining Planning Taking Notes	Gathering ideas Finding information Checking facts
Writing	Composing including creating text types such as lists, tables Importing images, graphs, and charts	Collaborating, Finding facts, Locating images
Revising	Reading using text to speech, Copying, moving, modifying and deleting text, Collaborating through tracking changes, and highlighting Using AutoSummarize to highlight topic sentences	Collaborating by sharing and reviewing Checking facts
Editing	Checking and correcting grammar and spelling Copying, moving, modifying and deleting text Checking word counts and readability statistics	Checking grammar and spelling, Verifying and correcting facts
Publishing	Formatting, selecting fonts and font sizes, illustrating Adding images	Printing, distributing, posting on webpage and wiki

**ICT Knowledge and Skills In the Writing Process**

Just as students need to acquire manual writing skills using pencil and paper before learning to write, they need similar skills using technology before learning to write using a computer. This section reviews research to address the question, to master the writing process at the fourth grade level, what technical skills and computer literacy knowledge do students need and how should these skills be taught?

There are six ISTE NETS for Students Standards, the first five standards address technology in the context of higher order skills; the sixth standard addresses basic technology concepts and competence (International Society for Technology in Education, 2007). Table 5 categorizes many of the skills students need to effectively incorporate technology into the writing process. While many of these are computer literacy skills that develop without direct instruction when students have frequent access to computers, these skills can be incorporated into classroom activities as mini-lessons in response to student questions, or shared during student collaboration (van Leeuwen & Gabriel, 2007).

Table 5

*Technology Skills in the Writing Process*

Category	Skills
Keyboarding Skills	Locate letter, number, other characters
	Use shift, caps lock, numlock keys
	Use Cursor control keys
	Use function keys
	Use control keys for system operation
	Use control keys word processing software
Mouse Skills	Move, point, left click, right click, double click, use scroll wheel
	Point and select from menu
Trackpad, Trackpoint	Control cursor, use gestures for scrolling
Word Processing Software	Start new word processing document
	Control application using menu bar and toolbox options

Category	Skills
	Insert, delete, move, change text
	Highlight text with mouse
	Change font style, size, and color
	Format text as bold, italics, underline
	Align text
	Create lists, and tables
	Insert Images
	Print
Internet	Operate web browsers
	Use common search mechanisms
	Use Internet terminology
System Software Operation	Login, logout, suspend, shutdown, restart
	Basic distinctions between software programs
	Manipulate and use multiple windows
	Debug basic system problems
File Management	Save, retrieve, create, delete, copy files
Hardware - system units	Use power controls, ports for external devices
Hardware - monitors	Use power and configuration controls
Laptops	Use power controls, and save handling techniques

Both handwriting and keyboarding require instruction and practice to develop automaticity and speed. The average composition rate using a keyboard and mouse for frequent computer users has been measured at 19 words per minute (wpm) (Karat, Halverson, Horn, & Karat, 1999). As Zeitz (2007) wrote in his keyboarding blog, the primary factor in achieving equivalent skill in keyboarding is time spent on the keyboard:

There is no reason in the world that fourth graders shouldn't be able to key at 20 wpm. The typical 9 year old child handwrites at about 16 wpm so if you can get them to keyboard faster than that, they are ahead of the game. The reader can read it AND it's in the dynamic world of word processing which means that their work can be easily revised and improved. This supports the improvement of writing skills as well as keyboarding skills (para. 1).

To prevent the development of bad habits, the time to introduce correct keyboarding techniques is when students start using computers, which may be as early as preschool (Zeitz, 2008).

Current research supports keyboard instruction in early elementary grades, when students begin using the keyboard to input words and sentences (Rogers, Laehn, Lang, O'Leary & Sommers 1997; Zeitz, 2008; Lockhart & Zeitz, 2010). Recognizing that keyboarding is a psychomotor skill similar to playing a musical instrument in some ways, Rogers et al. (1997) asserts that keyboarding instruction should be

- structured, scheduled daily for a specific amount of time until all keys have been introduced (usually four to six weeks);
- consistent, taught to all students in the class, with proper technique required by all staff; and
- sequential, instruction and practice continues in succeeding grades and correct technique always reinforced.

This is consistent with Zeitz (2008) description of the three stages of learning to keyboard: the cognitive phase where the students are learning physical technique and the location of individual keys; the associative stimulus stage where kinesthetic memory traces are developed by practicing exercises; the autonomous muscle response phase where automaticity is developed. Lockhart and Zeitz (2010) found that fourth grade students significantly improved their keyboarding skills over a four week period with an hour of instruction and practice every day. I saw very similar results in 2010 as an intern teaching a fourth grade keyboarding boot camp, with the addition of covered keyboards and keyboard charts (Snow, 2010a). I also found that without keyboarding instruction most adults who regularly use a computer achieve at least the average composition rate, 19 wpm (Snow, 2010b).

The computer literacy skills shown in Table 5 are not meant to be a definitive list of all skills a student needs to know, but to illustrate the breath of knowledge that is required to use technology in the writing process. Students learn many of these skills through collaboration, exploration, and access at home; however these skills should not be overlooked and should be reviewed and explained as part of regular writing process instruction when technology is included.

### **Findings**

How have English Language Arts, and ICT standards converged to specify the writing process instruction for fourth grade students? ICT has become part of the English Language Arts National Standards, clearly articulated in both the NCTE and the CCSSO standards. The CCSSI English Language Arts writing standard that addresses this question, which has been reviewed by the NCTE, is:

With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting (2010a, p. 21).

Without specifying details, such as computer software or keyboarding speed, this standard establishes a well-defined objective to use ICT in all steps of the writing process. As of March 2011, 80% of the states have adopted the Common Core State Standards (CCSSI, 2010b).

How does current research describe the writing process phases, steps, and activities? As observed by Hirsh (1996), one difference between experts and novices is that experts are aware of, monitor, and evaluate their mental strategies. The research shows that to move from novice to expert requires both the acquisition of skills and knowledge. The writing process is a

framework; the student develops an awareness of this framework while moving from novice to expert; the teacher uses this framework as a guide to develop the students writing abilities.

How is technology incorporated into the writing process at the fourth grade level? As Table 4 demonstrates, ICT is a natural partner in the writing process steps, enabling and supporting the recursion and looping that occurs as the author moves between the various writing process phases and activities. This year, the NAEP Writing Assessment for eighth and eleventh grades will be administered and require composition on the computer, in 2019 this assessment will most likely require fourth grade students to compose on the computer (NAEP, 2010).

To master the writing process at the fourth grade level, what technical skills and computer literacy knowledge do students need and how should these skills be taught? While there is a long list of ICT skills shown in Table 5, keyboarding is the fundamental skill, just as handwriting is a fundamental skill in English Language Arts. To prevent the development of bad habits, students should begin learning to keyboard, when they begin entering words and sentences as part of using computers in the classroom. Zeitz (2008). Many of the other ICT skills are demand driven, easily taught and more efficiently learned, as the need arises.

### **Summary and Discussion**

Research supports incorporating ICT into the writing process at the fourth grade level, and confirms that it is developmentally appropriate, and even motivating. The research also recognizes the dependent skills and prerequisite knowledge that must be acquired for students to focus on learning to write. While technology supports all elements of the writing process, paper and pencil are still the tools of choice for writing process instruction.

Students in the fourth grade are still writing and revising compositions using pencils and paper, while the computers sit idle in the corner of the classroom. Perhaps this is because many

standardized tests that include written composition are still taken with paper and pencil. One of the errors in research on technology in education has been to assume that if computers are in the classroom the students are using them. What are the inhibitors, what is keeping teachers from integrating the technology into the lessons? Is it the incompatibilities between technology and education; the role change for the teacher from the provider of knowledge to the coach or consultant; the standards and the emphasis on assessment; the teachers fear of being replaced or becoming redundant (Collins & Halverson, 2009)?

### **The Impact of Technology**

New technology creates change, which impacts cultures and societies. The computer and word processor fit well into the writing process; however the corequisite changes in public education are slower to occur. The computer is not the first technological innovation to impact teaching. As described by Moxley (2001) in *New Media Scholarship: A Call for Research* the concern about the impact of new writing methods has occurred before. Consider these claims frequently included in presentations by James Morrison, editor of *On the Horizon*:

Students can no longer prepare bark to calculate problems. They depend instead on expensive slates. What will they do when the slate is dropped and breaks?

1703 (Teachers' Conference)

Students depend on paper too much. They no longer know how to write on a slate without getting dust all over themselves. What will happen when they run out of paper?

1815 (Principal's Association Meeting)

Students depend too much upon ink. They no longer know how to use a knife to sharpen a pencil.

1907 (National Association of Teachers)

(Moxley, 2001, p. 39).

Students today still know how to sharpen a pencil using a knife, as evidenced by fourth graders' continued fascination with small plastic sharpeners that make beautiful curling wood shavings. Handwriting skills have not disappeared, nor will they in the near future; employers advertise their requirements for neat handwriting in addition to their requirements for word processing and spreadsheet expertise; doctors take courses in handwriting repair rather than risk the safety of their patients with illegible scrawling; college students find that rapid, good handwriting is essential for taking notes, and for writing thank you letters to grandmothers (Florey, 2009).

Consider Gutenberg's invention of moveable metal type for the printing press in the 1400s. Shirky (2008) observed the impact of this invention, "for the first time in history a copy of a book could be created faster than it could be read" (p. 67). He also noted that while the Protestant Reformation was not caused by this invention, it would not have been possible without it. Social change is driven by new technological capability, however the social effects lag behind technological ones by decades (Shirky, 2008). Public education has many social aspects or components. Word processors and computers are used almost exclusively for writing in both business and industry, whereas thirty years ago secretaries typed most business correspondence; however students in many classrooms continue to use pencil and paper for most of their work.

The fact that culture is slow to change is another reason why new technology is slow to move into the classroom. A well designed, model study done by Wright and Nuthall in 1977, and described by Nuthall in his 2005 narrative *The Cultural Myths and Realities of Classroom*

*Teaching and Learning: A Personal Journey* found that there were no discernable differences in teaching styles or student learning between experienced and pre-service teachers, leading him to conclude that that basic patterns of teaching do not change significantly over time. As cited in Nuthall (2005), similar results were found in the Third International Mathematics and Science Study (TIMSS), which concluded that teaching is a cultural ritual that is assimilated during our experience as students (Stigler, Gonzales, Kawanaka, Kroll, & Serrano, 1999). This research plus additional instances cited in his narrative led Nuthall to observe “Teaching, like language, has its own underlying structural rules and, like language, it is simultaneously both highly creative and tightly rule-bound. .... we had begun to uncover the ritualized routines that make up the culture of teaching” (p. 897 – 898).

### **Integrating Technology**

Few teachers have integrated technology into their daily teaching practice and lesson delivery (Cuban & Cuban, 2007). Computers are used as supportive extra materials, as flashcards for drill, and as typewriters for the final draft of the composition. One key reason is that technology is not a priority; there is not time for both the teacher and student to acquire their respective prerequisite skills (Lovell & Phillips, 2009). Weston and Bain (2010) have proposed that this may change with the introduction of one-to-one laptop programs in the classroom. They also observed that technology has been integrated and utilized well in many professions, such as medicine and finance; however in education while there has been some replacement such as computerized report cards, interactive whiteboards, and clickers, these replacements occur at the periphery not the core activity of teaching and learning. In professions where laptops and similar technology have been holistically integrated, it is difficult for professionals to imagine teaching

or learning without these tools (Weston & Bain, 2010). This may be the source of the vision that is driving the one-to-one laptop programs in schools.

In the book, *Teachers and Machines: The Classroom Use of Technology Since 1920*, Cuban (1986) describes teachers as being very different than engineers, whereas engineers are interested in efficiency and accuracy, completing tasks, meeting objectives, and producing specific outcomes; teachers have a more holistic perspective. They are more interested in seeing student progress in subjects than mastery of specific facts or skills. According to Cuban (1986), “teachers believe that interpersonal relations are essential in student learning, the use of technologies that either displace, interrupt, or minimize that relationship between teacher and child is viewed in a negative light” (p. 60). In this book, in order “to demonstrate anew the ambitious claims of classroom computer advocates, as well as to suggest the skeptical note in their claims” (p. 72) Cuban also includes a quote from Papert in a 1984 article *Trying to Predict the Future in Popular Computing*:

There won't be schools in the future.... I think the computer will blow up the school. That is, the school defined as something where there are classes, teachers running exams, people structured in groups by age, following a curriculum-all of that. The whole system is based on a set of structural concepts that are incompatible with the presence of the computer. ...But this will happen only in communities of children who have access to computers on a sufficient scale (p. 38).

Papert's 1984 prediction on the future of schools is very similar to Peterson's (2010) view of online schools in the final chapter of his book *Saving Schools*. Papert's prediction is consistent with the “disruptive innovation” theory to explain technological innovation that was developed by Christensen, Horn, and Johnson (2008). This theory proposes that disrupting technologies

initially enter the market by appealing to customers not served by established firms. The established well-managed firms ignore the new innovation until it becomes established and impacts their customer base and profit. Consider the personal computer introduced by Apple in the late 1970s as a toy for children, and then consider Apple's position in the market today (Moe & Chub, 2009). The result is significant social change driven by new technological capability.

Because social effects lag behind technological ones by decades, real revolutions don't involve an orderly transition from point A to point B. Rather, they go from A through a long period of chaos and only then reach B. In that chaotic period, the old systems get broken long before new ones become stable (Shirky, 2008, p. 67-68).

Shirky (2008) is describing the effect of moveable type on the Protestant Reformation with twenty-twenty hindsight, while Papert (1984), Peterson (2010), and Christensen et al. (2008) all see that computer technology will have a significant impact on public education.

### **Conclusion**

Thinking back to the original question, how is technology incorporated into the writing process as it is taught to fourth grade students; this question led to the analysis of the impact of technology on one very specific component of the curriculum, the writing process, at a single grade level, the fourth grade. The analysis of technology in the writing process provided the context in which to explore the larger questions: both the impact of technology on public education, and integration of technology into public education.

### **Further Investigation**

The integration of technology in the writing process in the fourth grade, and in public education in general, raises some questions that merit further investigation.

Does writing composition improve significantly when students' keyboarding skill has reached the speed and accuracy for comfortable composition rate (about 19wpm), and they are familiar with both the word processing software and the general system operation? While many studies measured the change in composition quality and quantity when technology was incorporated, usually the students in these studies lacked ICT skills and experience. In many cases keyboarding practice and ICT instruction were included in the studies (Goldberg et al., 2003). In my experience with fourth grade students, after six weeks of regular focused keyboarding instruction, students produced lengthy and interesting stories on the computer (Snow, 2010a). I would like to do further research to measure the change in writing composition quality and quantity after students have acquired the prerequisite skills and significant experience using computers and word processing.

How much computer literacy can students learn through exploration and collaboration? Computer software in combination with Internet searches and peer collaboration support this method of learning; software provides assistance through tutorials, helps, and prompts; a well worded Internet query frequently yields an immediate answer, often including a step by step procedure. Other users are often enthusiastic about providing assistance. This is an important area to consider, as some adults in technical jobs prefer to learn by this method of exploration, while others still prefer whole class instruction. Some students still do not have access to computers outside of the classroom, nor are they given time for exploration in the classroom.

In *School Figures: The Data Behind the Debate*, Skandera and Sousa (2003) validate the proposition "Home education is the fastest-growing alternative to public schooling, and a good one at that" (p. 266). Test score analysis shows that by eighth grade, median test scores for home-schooled students are four grade equivalents higher than students in public schools. Little

is known about how technology is used in this type of education and warrants further investigation.

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