ISSN: 1756–5839 (PRINT)
ISSN: 1756–5847 (ONLINE)

writing & pedagogy

Reflections on Practice

# Learning to Write in the Laptop Classroom

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**Abstract**

*The teaching and learning of writing was examined in ten diverse K-12 schools in which all of the students in one or more classrooms had individual access to laptop computers. Substantial positive changes were observed in each stage of the writing process, including better access to information sources for planning and pre-writing; easier drafting of papers, especially for students with physical or cognitive disabilities that made handwriting laborious; more access to feedback, both from teachers, who could read printed papers much more quickly than handwritten ones, and, in some schools, by automated writing evaluation programs; more frequent and extensive revision; and greater opportunities to publish final papers or otherwise disseminate them to real audiences.*

KEYWORDS: EDUCATIONAL TECHNOLOGY; LAPTOPS; ONE TO ONE, WRITING; COMPOSITION

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WAP VOL 1.1 2009 101–112
doi : 10.1558/wap.v1i1.101

## Introduction

Even though writing is considered one of the "3 Rs," it has been substantially neglected in U.S. schools (National Commission on Writing in America's Schools and Colleges, 2003). The relatively few informational resources available in a typical classroom limit students' ability to gather background information for their writing. In many cases, students tire easily from writing by hand or suffer from poor handwriting that cannot be easily deciphered by their peers or teachers. And it is difficult for students to revise their handwritten work, as they need to either erase parts or rewrite their entire paper.

In response to these and other challenges, some educational reformers have been promoting one-to-one laptop programs, which provide all students in a school access to computers throughout the school day and at home (for overviews, see Johnstone, 2003; Rockman, 2003). This paper summarizes the pedagogical findings of a study (Warschauer, 2006, 2008) on the use of one-to-one laptops on literacy instruction in 10 elementary, middle school, and high schools in California and Maine. Students in these schools use laptops in grades ranging from second to twelfth. The schools are located in urban, suburban, and rural settings and in wealthy, middle-class, and poor neighborhoods, and include ethnically diverse student populations. Data collected included 650 hours of classroom observations; 191 interviews of administrators, teachers, students, and parents focusing on how laptops were used for instruction and the differences perceived between learning with laptops and learning in a traditional classroom; and an array of school policy documents, teacher instructional materials, and student test scores, assignments, and records.

Data were analyzed to identify key patterns within each research site and make comparisons across research sites. All of the interviews and field notes were coded by means of the HyperResearch software program (ResearchWare, 2005) using a bottom-up coding scheme that considered whatever items of interest emerged from the data related to the overall theme of literacy and learning with laptops. A total of 381 separate codes were generated (e.g., "writing-computer vs. hand," "writing-peer review"), and 3397 instances of these codes were marked.

The survey, observational, and interview data all indicated that writing and editing papers was one of the two most frequent uses of laptops in the ten schools. (The other most frequent use, finding online information, also strongly affected the writing process.) Furthermore, in both the California and Maine schools, English Language Arts featured more consistent and frequent laptop use than any other subject, thus contradicting popular belief that the most natural educational match for technology is with science and mathematics instruction. Beyond frequency of use, it also became clear that laptop use had a major impact on instruction at each stage of the writing process, as summarized below.

## Pre-Writing

Pre-writing involves thinking about both the *subject context* (what one knows about the topic or subject matter of writing), the *personal context* (what one intends to say about the subject matter; see discussion in Rohman, 1965), and the genre of writing. Teachers in the laptop classroom made use of technology to assist each of these aspects. Students frequently consulted the Internet to get background information related to their writing. For example, at Carlton High in California (names of schools, teachers, and students are pseudonyms), Ms. Gonzales had her students do online searches for images they were passionate about and then discuss the images in class before writing poems about them. In some cases, Ms. Gonzales's students would engage in such discussions orally; in other cases, they would conduct such discussions online, to provide opportunities for written reflective discussion before essay writing. This allowed students to try out phrases, ideas, and ways of explaining things in writing before beginning a formal essay.

The most common use of technology in pre-writing reported by teachers was the use of graphic organizers. Students made use of a variety of software for this, including Inspiration (Inspiration Software, 2005), Smart Ideas (Smart Technologies, 2006), My Access (Vantage Learning, 2006), or simply AutoShapes in Microsoft Word. These tools provide a variety of types of scaffolding for planning writing. For example, the essay planning template in Smart Ideas, used at River Elementary in California, prompts students to fill in shapes indicating the thesis statement, the three main ideas, three pieces of evidence for each idea, and a conclusion. Inspiration software, used at Plum High in Maine and Flower School in California, allows students to automatically convert their diagrams into outlines. The pre-writing tools in My Access are much more elaborate. For example, they invite students to respond to a variety of written prompts (such as listing the pros and cons of a persuasive argument) and then convert these into essay text.

## Writing Drafts

Laptops were used extensively for the drafting of written texts. Two important advantages of drafting by computer (above and beyond the advantages discussed below about easier revision) emerged: the physical ease of writing by computer rather than by hand and the types of scaffolding of writing made available via computer. Almost all written work was done on laptops, with three exceptions. First, a minority of students chose to write first drafts by hand and final drafts on computer. Second, a few teachers preferred to do certain work by hand for a personal touch. For example, an elementary school teacher at Flower School had her students write weekly handwritten letters to their parents

reporting on their progress for a personal mode of student-parent communication. Third, some teachers occasionally assigned students to write essays by hand to prepare them for state examinations. These teachers, as other teachers who were interviewed, believed that writing by computer encouraged a better writing process (e.g., by facilitating more revising), but they felt obligated to at least occasionally offer their students the opportunity to practice writing by hand so as to more closely duplicate conditions similar to those of high-stakes examinations. All of these exceptions taken together encompassed under 10% of student instructional writing that we observed.

### Keyboard vs. Hand

Most children related that they find it easier and more enjoyable to write by computer than by hand, and teachers commented that students write at greater length on laptops. As a teacher at Henry Elementary school explained:

> They are writing more, it's better quality, it's produced faster. I think the laptops facilitate the writing because there is less fatigue involved than with cursive or print. Again they have the Internet right there to pull up graphics, they have Apple works drawings to illustrate their stories, so I think the laptop is a great facilitator of writing. I'll give my students prompts to write a short story, and usually before the stories were 2–3 pages, but this year, their short stories are 8–10 pages long.

The advantages of writing by computer appeared to be multiplied for students who were good keyboarders, with both observations and interviews indicating that poor keyboarding skills hampered the learning experience of some students. All students picked up keyboarding to some extent, but there was great variation in this matter due to differences in students' home experience with computers, length of time they had been using computers at school, and prior or concurrent formal school instruction in keyboarding.

Students frequently commented that their weak handwriting skills discouraged them from writing, and teachers often pointed to the difficulty of reading students' handwriting. The difficulty of writing by hand – and thus the corresponding benefit of laptops – appeared to be magnified for students who have special difficulties with coordination, motor skill, or cognitive function. A special education teacher in Maine commented on the advantages of laptops for her students:

> [It's been] absolutely phenomenal. For many of our students with cognitive disabilities, getting the ideas from your brain onto paper is pretty much a torture. But whatever reason, and the reasons are as different as the

> individual students are, word processing as opposed to writing has been an incredible tool in terms of creatively being able to express themselves and then also working on just the mechanics of written language. We see it over and over again. It's been a plus. It levels the playing field sort of with their peers…. When you're receiving special education services, it's all about alternatives. You don't fit into that little paper and pencil box.

### Scaffolding Tools

A second major advantage of drafting by computer was the various scaffolding tools available in word processing software and the Internet. Virtually all students used spell checkers as part of their writing, and many also used grammar checkers, dictionaries, and thesauruses. Few students could use all of these tools expertly, as the tools themselves require some underlying linguistic knowledge to use well, but most indicated that they benefited from them.

Teachers in the ten schools had diverse feelings about the use of such scaffolding tools in the classroom. Most praised them, believing that they provided assistance to students to correct and improve their papers autonomously. One language arts teacher in California went so far as to allow her students to use the spell-checker on their spelling tests if they wished. She believes that because students will have access to spell-checkers in the real world, it is more important for them to learn how to use them correctly than to function without them. In contrast, two of the teachers interviewed reminisced about the old days when what one of them called "hard-working students" learned spelling, grammar, and reference/citation matters without needing to resort to computer-based tools in contrast to the "lazy students" today who overly relied on such crutches.

## Rewriting

Teachers and students who were surveyed reported that students revised and edited their work more in the laptop class then they did in traditional classrooms. Our observations and interviews suggested writing on laptops helped the revising process in three ways. First, it made the written product more readable and thus easier to evaluate. Second, it provided alternate mechanisms for provision of feedback. Third, it greatly facilitated students' ease at making changes to papers.

### Reading and Evaluating

According to teacher and student reports, word-processed text, whether viewed on the screen or printed out, was in general much easier to read than handwritten text. This made it easier for students to check their own work and for students' peers and teachers to review papers and provide feedback. Such review often took place at the screen, as pairs of students would work together and comment on each other's work, or a teacher would quickly read and comment on a student's writing. It also took place as teachers read and reviewed drafts that were printed out and submitted. As a middle school teacher in California commented, "They're easier to read. Things are clearer and they stand out for me. I can find things a lot easier on the essays [that are printed out] when I'm looking for them too." A high school teacher in Maine told us that she had read about 100 printed student essays the evening before in one hour and 15 minutes, but that 100 handwritten essays would have taken her half a day to read.

### Providing Feedback

The laptop classroom also allowed additional opportunities for the teacher and students to provide feedback on others' writing. In some cases, this was done electronically, as comments were made directly on a document, for example, using the Track Changes or Insert Comments features of Microsoft Word. In other cases, this was done by hand, but facilitated by the fact that word-processed essays could be set with wide margins or double line spacing to allow more room for written comments. The most radically different form of feedback we witnessed was through automated writing evaluation, which will be discussed later in this paper.

### Editing and Revising

Most importantly, once students decided to make changes on an essay, they could do so much more easily by computer than by handwritten essay. As a middle school student in Maine related: "If you make a mistake in [hand]writing then you have to write arrows and scribble stuff out, but on the computer you can just delete them and cut things out and paste things where you want." In the observed laptop classes, a much more iterative and natural writing process occurred than in the typical classroom. Students frequently and constantly revised their work as they wrote it, deleting words or sentences, moving text around, and correcting mechanical errors. They also frequently wrote multiple drafts of their papers. A typical pattern might involve writing one draft that

was then reviewed by peers, another draft that was reviewed by the teacher, and then a final draft.

A middle school teacher in Maine summarized some of the differences in the feedback and revision process between the typical and laptop classroom:

> As a teacher, the most exhausting part of my job was one-to-one writing conferences, especially when you have the red pen out, you can't read their writing, you've got to squeeze in comments in the lines – two or three of those a day were all I could handle. And it was harder for them afterward to go back and remember. So when you have the laptop, it's live, it's right there, you are editing, you are conferencing together. When I need to give them feedback on revisions they needed to make, it was easier for them to just take what I offered and go back right there and do it.

Yet the observations and interviews suggested that broader curricular and testing structures sometimes impeded extensive revision using laptops. For example, a middle school teacher in California explained that she simply had too much material to cover in order to meet state standards and prepare for high-stakes testing to be able to allow students time to write multiple drafts of papers. Other teachers indicated that they sometimes preferred to have students write only one draft to better mimic conditions of state writing exams.

## Dissemination

Public sharing of student writing was witnessed in laptop classes in more diverse and varied ways than in the typical classroom. Most of the laptop classrooms were print rich, with student work posted throughout the classroom. In some classrooms, multiple versions of student work were posted – including brainstorming maps, first drafts, and final drafts – to signal the importance of the overall writing process. On other occasions student work was read aloud. One interesting example of this was at Castle Middle School in Maine. A language arts teacher there, Ms. Evans, invited her students to deposit printouts of their creative writing, whether poetry or prose, anonymously into a "ThoughtPot" throughout the week. Every Friday the class sat in a circle while Ms. Evans picked out and read student work. Working with laptops allowed students to write higher quality work (e.g., through more revision), to experiment creatively with formatting (e.g., through mixing different fonts and spacing in their poetry), and to discuss their private feelings in their poetry anonymously (since word-processed texts cannot be identified as readily as handwritten texts). Later, the students and teacher published the best work from the ThoughtPot in a book of poetry.

Students in laptop classrooms also shared their work with distant audiences. Students at several of the schools wrote and sent correspondence, for example, to inquiry about career or educational opportunities. Elementary school students in California also wrote book reviews which they published on Amazon.com. Writing for authentic audiences was especially prominent at Howard Middle School in Maine. Students there carried out email exchanges with students in Greece (in English) and in France (in French). In one of the most elaborate and rewarding projects, students in the school's Spanish class authored, formatted, and printed out Spanish-language children's books that were then distributed via a humanitarian organization to children living at the Guatemala City garbage dump.

Writing for a real audience provided a motivation and purpose for student writing and helped students focus on the perspective and level of their readers, thus assisting students to transition from writer-based to reader-based prose (see discussion in Flower, 1984).

Students writing for a real audience also paid greater attention to the accuracy of their writing. As a teacher involved in the exchange program with Greece explained:

> It made them more aware of "I need to know how to spell this because someone is going to read this, and I don't want them to think, oh look at the American who wrote this and they don't know how to spell that." That kind of thing made a big difference in their writing, because they really want to know "Is this right?," because they realized they have an audience.

## Automated Writing Evaluation

Three of the observed schools made use of automated writing evaluation software, which generates scores on students' essays through comparisons to the syntactic, semantic, and discourse features of essays previously scored by hand (for overviews of such software, see Shermis and Burstein, 2003; Warschauer and Ware, 2006). My Access, which was the automated writing evaluation program used in the these three schools, also includes a variety of student writing tools (e.g., model essays, graphic organizers, thesaurus, dictionary) and provides individualized feedback on spelling, grammar, and word usage (similar to that provided by Microsoft Word, but in more detail), generic feedback on organization and development, and detailed individual or class scoring reports to teachers.

Both teachers and students had a generally positive attitude toward the software. Students would shout with joy when they got a high score, and would look for ways to improve their paper when they didn't think their score was

sufficiently high. Students tended to concentrate most of their revisions on mechanical aspects, such as spelling, punctuation, and grammar, although this seemed consistent with what takes place more generally in K-12 schools.

In some ways, the use of automated evaluation tended to reinforce formulaic writing, as students occasionally dropped colloquial language or nontraditional structures to try to get a high score. The use of automated scoring systems could also be seen as contradicting one of the major potential advantages of computer-based writing – that it allows for more meaningful writing activities directed at real audiences. However, all of the classes observed had a balanced combination of writing activities, which included some papers written for My Access and other assignments for more authentic purposes and audiences.

According to our observations and interviews, a major advantage of automated writing evaluation was that it engaged students in autonomous activity while freeing up teacher time. Teachers still graded essays, but said that they could be more selective about which essays, and which versions, they chose to grade as compared to in their previous teaching. In many cases, teachers allowed students to submit early drafts for automated computer scoring and a final draft for teacher evaluation and feedback. A teacher at Flower summarized some of the strengths and weaknesses of automated writing evaluation in the classroom:

> I think it makes teaching easier. It's like another pair of eyes, however good or bad those eyes are. It's still much better than what I could do by myself. I have to monitor it, but you have to monitor everything, because I am responsible totally for what goes on in the class. I can't just leave it to something else, and you turn it on, and it puts it into their brain, and then you're done.

Those who harshly criticize the specter of automated writing evaluation (see, e.g., Cheville, 2004; Conference on College Composition and Communication, 2004) overlook the fact that good writers already make use of computerized feedback tools, such as spelling and grammar checkers. The expansion of these tools to include more detailed feedback and numerical scores need not raise an alarm if the tools are used appropriately. As suggested by the teacher quoted above, such automated systems do not replace good teaching but should instead be used to complement and support it.

Finally, though outside the scope of this paper, it should be noted that writing test scores have increased significantly in Maine after three years' implementation of the statewide laptop program (Silvernail, 2007). This is in spite of the fact that standardized writing examinations are considered insensitive to the full benefits of computer-supported writing, which, unlike timed writing tests, involve the use of computer- and Internet-based information and scaffolds,

multiple revisions over a period of time, and response to feedback (see discussion in Warschauer, 2006). In one of the California school districts where our research group systematically compared changes in English language arts scores among laptop and non-laptop students, we found a first-year drop in scores among laptop students followed by a corresponding second-year rise, suggesting that effects on test scores may also be impacted by the learning curve for both teachers and students associated with making use of one-to-one computers in the classroom (see Grimes and Warschauer, 2008).

## Conclusion

The daily use of laptops in our 10 case study schools had a major effect on instruction at each stage of the writing process, including pre-writing, drafting, rewriting, and dissemination. Though the particular way that computers were used was shaped by the nature of K-12 schooling, and especially its emphasis on high-stakes testing, overall student writing in these schools became better integrated into instruction, more iterative, more public and collaborative, more purposeful and authentic, and more diverse in genre, while students' written products improved in quality and student writing became more autonomous (for details, see Warschauer, 2006, 2008). One-to-one laptop use is not a magic bullet to solve all educational problems, but our study suggests that it has a substantial positive impact on the teaching and learning of writing. Educators who are concerned with promoting the kinds of writing and literacy skills required of 21st century life will do well to prioritize implementing one-to-one laptop programs in their classrooms.

### Acknowledgements

Research for this article, the main content of which is summarized from Chapter 4 of Warschauer (2006), was carried out with the assistance of Paige Ware, Michele Rousseau, Kelly Bruce, Doug Grimes, LaWanna Shelton, Melanie Wade, Jorge Velastegui, Kurt Suhr, Vanitha Chandrasekhar, Bryan Ventura, and Julia Nyberg. Funding was provided by the Ada Byron Research Center for Diversity in Computing & Information Technology and the Cultural Diversity Program of the Academic Senate Council on Research, Computing and Library Resources, both at the University of California, Irvine.

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