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# Promoting academic literacy with technology: successful laptop programs in K-12 schools

Mark Warschauer [a,*], David Grant [b], Gabriel Del Real [c], Michele Rousseau [d]

[a] *Department of Education, University of California, 2001 Berkeley Place, Irvine, CA 92697-5500, USA*
[b] *Portland Public Schools, Maine, USA*
[c] *Newport-Mesa Unified School District, California, USA*
[d] *University of California, Irvine, USA*

**Abstract**

One of the main challenges that US schools face in educating English language learners is developing their academic literacy. This paper presents case studies of two K-12 schools that successfully employ high-technology environments, including laptop computers for each student, toward the development of English language learners' academic language proficiency and academic literacy. In the first school, Latino fourth-grade students use laptops and other new technologies for a wide variety of pre- and post-reading tasks as part of their effort to transition from learning to read to reading to learn. In the second school, diverse immigrant and refugee students at the middle school level combine technology use with Expeditionary Learning to carry out community projects leading to the development of sophisticated products. In both schools, technology is used to engage students in cognitively demanding activity, motivate independent reading, and provide scaffolding for language development, while the researchers also made use of technology to document learning processes and outcomes. Taken together, the schools offer valuable lessons for utilization of technology to promote academic literacy among culturally and linguistically diverse students.


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* Corresponding author.
*E-mail address:* markw@uci.edu (M. Warschauer).

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## 1. Introduction

The percentage of language minority students in US schools continues to grow, with nearly four million K-12 students receiving special instruction as English language learners (ELLs) (National Center for Educational Statistics, 2004). Many more non-native speakers of English graduate out of ESL programs to mainstream instruction, but have still not fully caught up with grade level instruction. Unfortunately, most language minority students never achieve academic success in the US, with great disparities between them and native English speakers in standardized test scores, graduation rates, college admission and completion rates, and adult wages (Noguera, 2001).

### *1.1. Academic literacy*

Virtually everyone who is born in the US or who immigrates to the country by the age of 12 becomes conversationally fluent (Greenberg et al., 2001). The major challenge that schools face vis-à-vis ELLs is not conversational fluency but rather academic literacy. Academic literacy can be defined as the reading, writing, speaking, listening, and thinking skills, dispositions, and habits of mind that students need for academic success. It includes the ability to critically read and interpret a wide range of texts, to write competently in scholarly genres, and to engage in and contribute to sophisticated academic discussion (Intersegmental Committee of the Academic Senates, 2002). While English learners develop basic interpersonal communication skills within a year or two, it takes them much longer to develop the knowledge of complex vocabulary, syntax, and genres that underpin academic literacy (Cummins, 1988). The development of this broader academic language proficiency requires five to seven years of instruction with several key elements, including large amounts of extensive reading, focused linguistic analysis of texts, and involvement of students in motivating and cognitively engaging learning activities and projects (Cummins, 1989a,b).

## 2. Laptops and literacy

New technologies have been promoted as a potent tool for helping language minority students develop the kinds of reading, writing, and thinking skills that contribute to academic literacy (see, for example, Cummins and Sayers, 1995; Warschauer, 2003). However, studies suggest that the actual use of computers and the Internet with language minority students in K-12 schools leaves much to be desired, due in part to the complexity of integrating new technology in instruction when students have uneven access to computers at school and home (Warschauer et al., 2004). Increasingly, school districts are experimenting with one-to-one laptop computing to provide more consistent computer access to students. The number of laptops in US schools is growing at the rate of some 60% per year (Market Data Retrieval, 2003). In most cases, schools place laptops on mobile carts that are used

by different teachers on an "as-needed" basis. However, an increasing number of schools are assigning laptops to individual students for daily use at school and home throughout the academic year (Johnstone, 2003). Relatively little research has been conducted to date on these one-to-one computing environments (for a summary, see Rockman, 2003), and virtually none of it focusing on language minority students.

## 3. The study

In this paper, we provide case studies of two schools that have successfully made use of high-technology environments, including one-to-one laptop computing, with language minority students. As part of a national study of K-12 one-to-one computing, our research team identified two schools that demonstrated exemplary models of laptop instruction with ELLs toward developing academic literacy. Following that identification, educators from those schools were invited to assist us in further documenting the educational practices at those sites. The collective authorship of this paper thus represents the collaborative effort of "outside" researchers and "inside" educators in identifying and documenting exemplary practices.

The authors of this report used standard qualitative methods, including observations, interviews, and collection of artifacts, with an emphasis on digital documentation of best practices. This paper thus highlights presentation and discussion of student work and projects in order to give the reader a close-up look at the ways that digital technology can be deployed for development of academic literacy among ELLs. The two schools involved in the study were quite different in terms of location, level, populations served, and pedagogical approach, but both are highly effective in achieving their goals. We begin by first discussing Adelante Elementary School in California, and then turn to Urbania Middle School in Maine. Both school names have been changed for the purposes of this report.

## 4. Adelante Elementary School

Adelante Elementary School is located in a low-income Latino community of California. Some 96% of the students in the school are Latino and 75% are designated as ELLs. As a grade 4–6 school, Adelante deals with students at a critical juncture for the development of academic literacy. Students in upper elementary school must go through a transition from learning to read, with a focus on decoding skills, to reading to learn, with a focus on comprehension of increasingly challenging expository texts across a number of content areas (Chall, 1996). This represents a special challenge for language minority students, who often begin to fall behind due to their limited mastery of vocabulary and syntax and insufficient cultural background knowledge, leading to what is widely referred to as the "fourth-grade slump" (Chall et al., 1990).

Adelante has strongly emphasized the use of new technologies to help their students meet the challenge of reading to learn. For five years, the school has been

implementing a computerized system, *Accelerated Reader*, for monitoring and evaluating independent reading activity (Renaissance Learning, Inc., 2004). Three years ago, a Technology Academy was developed in several classrooms, involving the use of interactive white boards (SMART Boards), access to two mobile laptop carts, wireless networking, and special professional development for teachers. This past year, the program was extended through the purchase of a third class set of laptops, which were assigned to one fourth grade language arts and reading class on a daily basis for use at school and home. Research for this study was carried out in that classroom, which meets 3 h per day and is taught by Mr. Molina. All but one of the 29 students in the class are Latino and native speakers of Spanish. Some 20 of the 29 are classified as English language learners, while the rest have reached the stage of fluency in English. The class is on the average six months to one year behind grade level in reading.

Mr. Molina was chosen by Adelante to teach their one-to-one laptop class based on his prior success in integrating technology into the reading and language arts curriculum. His class was selected for observation in this study as the one class at Adelante with one-to-one laptop computing. The school and district hope to expand the one-to-one laptop program through acquisition of additional equipment, so Molina's course was thus seen as a pilot effort. Molina is an exceptionally talented teacher – he was previously selected as Adelante's Teacher of the Year – so his results are not necessarily typical of what can be accomplished in any classroom with laptops, but they do demonstrate how technology can be combined with instructional excellence to promote academic literacy among non-native speakers of English.

### *4.1. Technology and language arts at Adelante*

Technology is used in Molina's class as a complementary piece to the language arts curriculum. The success of the laptop program in Molina's class is due to a deliberate integration of technology into the reading/language arts curriculum. Students are not taught technology skills in isolation. Instead, the technology skills are infused into each of the projects that Molina's students complete through thematic literature units. In Molina's class a SMART Board, Renaissance Learning Programs, the Internet, digital cameras, and computer programs such as SMART Ideas cognitive mapping software, *Microsoft Word*, *Microsoft Excel*, and *Microsoft PowerPoint* are used as media for projects where students interact with text. The goal of these projects is to refine the students' process of constructing rich meaning from text. Coupled with this wealth of technology are extensive opportunities for students to practice reading. The reading practice is structured as guided independent reading where the students make decisions about what reading comprehension strategies to use based on explicit instruction and modeling of reading comprehension strategies. Students become proficient at applying reading comprehension strategies to a variety of text genres as a result of diverse guided reading experiences through teacher modeling and cross-age tutoring activities that promote thorough examinations of text organization. One final piece in the successful implementation of laptops in

Molina's class is his ability to effectively manage behavior and promote elevated standards for student work through motivating literacy projects.

### 4.2. Pre-reading with Mr. Molina

Technology is used to complement and enrich the instructional experience, but it is a means to an end, with the collateral benefit of students developing technology skills in addition to their ability to engage in meaningful interactions with text. The interactive white board and Internet are integrated into pre-reading activities. Students come to the board to carry out vocabulary-picture matching activities, thus providing a foundation of background knowledge for the readings, as well as allowing students to employ vocabulary acquisition strategies that have more utility than pre-teaching a rigid definition of a word (see, for example, Picture1.jpg). Background knowledge is also built by drawing on the Internet resources relevant to literature themes, drawing on pedagogical sites such as *NetTrekker* (Thinkronize, 2003). Molina downloads content or images to the SMART Board to engage the whole class in a discussion of content, or the students visit websites individually through the use of a teacher created Webquest. These Internet experiences provide a platform for reflective discussions among students. Teacher led questioning about the Websites scaffolds the students' use of language by providing opportunities to practice using language with members of cooperative groups.

### 4.3. Independent reading

Once background knowledge has been adequately activated, the literature is read as a whole class. Molina's students, like the students in the rest of the school, also engage in 60 min independent reading per day. The library has some 16,000 books for which computerized quizzes are available in the *Accelerated Reader* program, and once students finish a book they independently take the quiz on a computer, and, upon passing, receive recommendations of further books at their level. *Accelerated Reader* has come under much criticism for failing to teach reading skills (e.g., Oppenheimer, 2004). However, at Adelante, the program is not used to teach reading skills or strategies, but rather to encourage and evaluate students' independent reading, and in that it is highly successful. The students at Adelante check out an average of one book per day from the library, and their reading scores are well above the state average for students of similar demographics. Molina closely monitors students' independent reading, having them fill out special cards to indicate the reading strategies they used (such as predictions made) and actively discussing with them the books they will or have read (see, for example, MSWord1.doc Excel1.xls).

### 4.4. Post-reading

The most focused use of technology occurs after the whole class reading of particular texts. Molina skillfully makes use of a variety of tools to help students deconstruct

texts and understand their genres and structures, key elements of academic literacy. Students use cognitive mapping software to outline and interpret texts. In the process, the students reread to locate and clarify key points, while organizing their understanding of the text into a visual representation (see, for example, PPT1.ppt). Searching for images that match text has further positive effects on student vocabulary development, while also developing students' technological skills. In order to search for images in clip art and/or the Internet, the students are forced to articulate their understanding of the text in a one-word summary.

Another post-reading project that exemplifies the use of technology to teach academic literacy is an extension project that stemmed from the story, *Sadako and the Thousand Paper Cranes* (Coerr, 1999). After the story, the students developed their ability to read and follow written instructions by folding paper cranes as a class. To explore organization of written instructions through the reading–writing connection, the students were required to design their own origami models and to write instructions for modeling their figure (see, for example, PPT2.ppt). This project served as a catalyst to promote students' connections from the written instructions they had just read, to the instructions that they were writing, thus taking advantage of the principle of pushed output (Swain, 1985), in which learners are pushed or stretched to attempt new language forms as a necessary part of making themselves understood. The students wrote the steps for their folding instructions on slides in *Microsoft PowerPoint*. Included on each slide was a digital picture that the students took of the steps for folding their origami model. After completing their instructions, the students printed out the instructions and a class origami book was created.

One fascinating example of technology for apprenticeship into communities of practice involved students writing customer reviews of *Sadako and the Thousand Cranes* for Amazon.com. Students first viewed some other customer reviews of the book on the SMART Board, and collectively critiqued them, discussing the particular features of an effective book review, such as how to provide an effective title, how to gain readers' interest, and how to avoid giving away too much through "spoilers". In examining already-published customer reviews, the students also took careful note of grammatical or spelling errors, and reinforced their own commitment to do better. Students then wrote their own reviews of *Sadako and the Thousand Cranes* and saved them on the school file server. Molina then made suggestions to the students through the use of the comment feature in *Microsoft Word*, and students retrieved their files and revised their reviews. The students submitted their reviews for publication on Amazon.com, and checked back with great delight a couple of days later to see that they had been published (see, for example, GIF1.gif and GIF2.gif). The activity emphasized for students both the iterative nature of writing, as well as the mindset of composing for a particular real-world purpose and audience, and also helped them by default learn many technological skills. Following this activity, some of the students in the class continued to submit reviews to Amazon.com even when not assigned by the teacher. This example and the previous one both point to how literacy became much more of a public event in the class through the use of digital technology.

One final use of technology in Molina's class is the organization of information through the creation of matrices. One project employed a matrix as a semantic feature analysis to connect stories in a literature theme. In this project the students created a matrix in *Microsoft Word* and recorded the titles and common elements of the stories within a theme. The goal of this is to help ELLs make a literal connection between stories in a thematic unit through a graphic organizer. Another use of a matrix was to study character development across a novel. Students were able to explore how the author uses characters' actions to portray key personality traits and motivations. In this project the students created a workbook in *Microsoft Excel*. Each worksheet within the workbook was named for a character in the book. On the worksheets, the students logged the characters' most significant actions and evaluated if the characters' actions had a positive or negative effect on the development of the plot (see, for example, Excel2.xls and Excel3.xls). The log was then analyzed by the students and they looked for trends in character behavior. As a summative evaluation, the students selected characters with dissimilar personality traits and wrote an essay comparing and contrasting the characters citing specific evidence from the text.

Observations at the school, as well as interviews with students and their parents, indicated an extraordinarily engaged group of students with a joyous attitude toward school, literacy, and learning. These results are of course not solely attributable to the laptop program or other use of technology. Rather, Molina and the school were able to make use of new technologies to build on their previously successful approach, which involved promotion of academic literacy through extensive reading, intensive attention to texts, and involvement in cognitively engaging projects.

## 5. Urbania Middle School

Urbania Middle School represents a different, but we feel equally effective, approach to using laptops to promote academic literacy. Urbania serves the most economically, academically, and linguistically diverse neighborhoods in the state of Maine. Among a population of 520 students in grades six through eight, approximately 24% of students are from immigrant or refugee families, speaking some 25 languages. The largest groups of ESL students come from Somalia and Sudan, with others from Afghanistan, Southeast Asia, the Middle East, Eastern Europe, and Latin America. Since the school serves as a major refugee relocation center, many of these students have little educational background in their own country prior to their arrival in the US. A majority of the native-English speaking white students at the school also face educational and social challenges, with some 70% of children in the surrounding neighborhoods coming from single-parent households and a nearly equal number living in poverty. If students at Adelante are faced with the prospect of a fourth-grade slump, Urbania's students face a similar but more severe threat known as the "eighth-grade cliff" (de León, 2002). Simply put, students who do not gain sufficient academic literacy skills by the completion of Middle School face so many challenges with increasingly difficult material that they often drop out.

Urbania has met this challenge with an ambitious educational reform effort that has actually raised test scores at the same time the school as become more culturally and linguistically diverse. Though Urbania has more English language learners than any other school in the state, its reading and writing test scores fall well above the state average. The educational reform at Urbania has developed in three stages. In the first stage, beginning in 1993, Urbania's principal and staff developed and implemented a Expeditionary Learning Outward Bound (ELOB) model (Expeditionary Learning Outward Bound, 2004), in which the main curriculum of the school is organized around 8–12 week interdisciplinary projects. In the second stage, beginning gradually in the mid-to-late 1990s, efforts by the school's technology coordinator and classroom teachers helped make new media central to many of the ELOB projects, with students using computers, the Internet, and other digital media to carry out their inquiry and develop products. In the third stage, beginning in 2002, the school issued laptop computers to all students at the seventh grade and eighth grade levels, and one-to-one computing further supported the reform effort.

The principal and staff's relentless commitment to overcoming educational inequity, conflict, and division in the school has been key to the overall reform effort. Before the reform effort began, Urbania was characterized by low test scores, deteriorating attendance and discipline, few extracurricular activities, low expectations for teachers and students, and a climate of hostility. The school ran on a master schedule with bells moving students among classes on 40 min intervals. Students were tracked in seven separate ability groups, and 24% of students were pulled out of classrooms for special education services. Today at Urbania, interdisciplinary teaching teams have authority to design their own schedules based upon the needs of their students and the curriculum. Passing bells have been eliminated. Students are no longer tracked, pullouts are reduced, and students are heterogeneously mixed in core subjects with the expectation that teachers would teach to all students. Teachers are encouraged and supported in developing and implementing thematic curriculum with effective middle level teaching practices. Related arts teachers, special education teachers, and reading specialists have been integrated into the teaching teams.

Teaching teams work together to develop the 8–12 week interdisciplinary units known as *Learning Expeditions* (Expeditionary Learning Outward Bound, 2004). In these units, teams of teachers and students collaboratively develop knowledge and skills around a set of guiding questions. Each expedition is composed of common segments including a kick-off (in which the context and the topic of inquiry for the expedition are introduced to students), a period of teacher and student directed learning, field work (visiting with experts both outside and inside the school), product development (developing a collective model of the knowledge and skills gained in the expedition), and a culminating event in which students share the final product with a significant audience. This integrative approach – of both students and curriculum – is implemented with the school's English language learners as well. Previously, all of the schools' ELLs were taught in self-contained ESOL classrooms. Today, the emphasis is on mainstreaming, with three-quarters of the ELLs integrated into the mainstream program, though receiving additional support for language

and reading. The beginning ESL students who have not yet been mainstreamed either participate in their own *Learning Expeditions* or sometimes join the expeditions of other students at their grade level.

Technology and project-based learning are combined at Urbania to promote learning in four ways: developing models of knowledge and learning with students, creating opportunities for instructional differentiation within the context of learning expeditions, constructing real products as the outcome of learning of expeditions, and preparing students to be producers as well as consumers of media.

### *5.1. Developing models of knowledge at Urbania: representing to learn*

The *Expeditionary Learning* model focuses on the relationship between learning and representation. This methodology is supported by research indicating that student's best master curriculum that they are required to represent, and consequently, that learning is extended by one's access to, and literacy and facility with, representational media (see discussion in Zemelman et al., 1998). In the last weeks of a learning expedition at Urbania, students and teachers typically finalize the design of the expedition product, create multiple drafts of individual student contributions, and assemble the work of all students in a single culminating product. Prior to the development of multimedia resources, products (and the learning processes for developing them) were limited to non-digital, largely linear, and difficult-to-edit media. Use of color artwork was limited due to expense of reproduction. Moving images, sound, and interactive models were limited to performance-based products. Though such products can play important roles in learning, many early student products at Urbania lacked the sophistication to represent non-linear systems of knowledge, and often emphasized form above content due the rigid nature of the media.

Through the introduction of multi-media production technology and strategies at Urbania, students and teachers have the means to construct appropriately sophisticated representations of curriculum. The use of new technologies enable students and teachers to create comprehensive representations of the processes and outcomes of learning expeditions through products that are rich in core content, connect discrete knowledge to broad concepts through hyperlinks, and include multiple forms of learning and expression.

### *5.2. Instructional differentiation*

Urbania's diversity and heterogeneous school design present obvious challenges to planning for the needs and potential of all students, especially English language learners. Teachers at Urbania use the time frame of expeditions and the design of multimedia final products to address questions of differentiation. A common technique involves developing a multi-tiered product in which each student is required to produce a discrete portion that demonstrates essential knowledge and skills. For many students, these requirements are appropriately challenging considering the duration of the project. Students who finish ahead of classmates, however, are expected to develop other portions of the product by carrying out additional re-

search related to the expedition or developing documentary video, audio or other media chronicling the expedition.

### 5.3. Constructing real products

A brief discussion of one expedition product, *Fading Footprints*, is illustrative of this process (see also Grant, 2004). *Fading Footprints* is a 12 week science, art and technology expedition student project that has been conducted twice at Urbania, most recently in 2003. Over the course of the expedition, students acquired knowledge of broad concepts of ecology in relation to specific species in Maine. The product for the expedition was a CD-ROM field guide cataloguing Maine's endangered wildlife, rich in scientifically correct species illustrations, individual species pages (see, for example, HTML1.htm, HTML2.htm and HTML3.htm) and broad ecology concept pages, and a student-produced documentary video of the learning process (see Mov1.mov). The final product was presented to the Maine Audubon Society and made available to the other elementary schools in the school district. An expository species page and scientific species illustration were required of each student. Those who finished constructed concept pages covering the broad themes of ecology (see HTML4.htm). Near the conclusion of the expedition, all 80 students reviewed each of the 20 concept pages produced by peers, and subsequently created links from their species pages to the concept pages most clearly connected to their species.

### 5.4. Students as producers of media

Working in a representation and media rich learning environment has important advantages for the diverse students, and especially ELLs. The incorporation of visual artwork allowed students to develop and display multimedia skills while they simultaneously develop their writing ability. The creation of a multi-tiered final product created opportunities for all students to do their best work while contributing to a collective product. When one views the final product, all of the work looks equivalent on the surface. The extra work, though immediately accessible through hyperlinks, lies beneath the surface and does not detract from the appearance of anyone else's work. Finally, students develop an ability to think critically about new media genres when they actually go through the process of producing new media rather than just consuming it.

Fading Footprints is just one of a number of Learning Expeditions student projects that students engage in at Urbania. Other recent expeditions have included Kings of Rhythm, a music and technology expedition in which all sixth graders film, edit and produce documentary video of their music classes (see Mov2.mov), and Four Freedoms, a mixed media humanities expedition about freedom of expression and social responsibility (see, for example, HTML5.htm, HTML6.htm, HTML7.htm, and HTML8.htm). An annual Celebration of Learning at Urbania showcases student work from these and other expeditions.

Though the approach at Urbania is different than that of Adelante, students similarly engage in all the practices that are considered critical for the development of academic literacy at the middle school level. First, the research for the expeditions involves extensive background reading, as students independently gather information for their contributions. Second, as students work to create their products, intensive work is done on editing and language scaffolding. Students are motivated to attend to issues of syntax, vocabulary, mechanics, and structure, knowing that their work is going to be made available to the public, while peer editors and teachers provide feedback to individual students and collectively. Finally, the projects involve students in motivating and cognitively engaging contexts, which maintains their interest level and pushes them to excel.

## 6. Conclusion

The promotion of academic literacy involves far more than "teaching English". Rather, it involves offering students "access to the ranges of knowledge, abilities, and forms of language" that will enable them "to lay claim to the social identities that afford them a participant status" in academic communities, and provide the scaffolding and supportive environment necessary for attainment of these (Hawkins, 2004, p. 23). New technologies are an extraordinarily valuable tool to facilitate this process. The use of computers and the Internet can provide support for extensive and independent reading and writing, assist with language scaffolding, and provide opportunities for authentic research and publication. Unfortunately, though, most K-12 teachers in the US have experienced great difficulty in effectively integrating new technologies in instruction of ELLs (Warschauer et al., 2004).

The two schools highlighted in this study represent very different instructional contexts. In the first case, a somewhat homogenous group of Latino English language learners focuses on language arts and reading at the fourth grade level. The underlying theme of the program is reading to learn. In the second case, a highly heterogeneous group of immigrant and refugee students take an interdisciplinary middle school curriculum, mostly in mainstream classes in a diverse urban school. The underlying approach of that program is *Expeditionary Learning* and representing to learn. Both schools make highly effective use of technology to promote academic literacy among their students, resulting in sophisticated student products, highly engaged learners, and high standardized test scores in relationship to school demographics. The keys in both cases are a school-wide commitment to excellence, equity, and development of classroom communities of inquiry. Technology is used to apprentice students into academic literacy through promotion of independent reading, support for language scaffolding, involvement in cognitively engaging projects, and student analysis and creation of purposeful texts in a variety of media and genres. Schools that look to technology as a magic bullet to transform education will be disappointed. Rather, new technologies serve as an amplifier that can magnify preexisting strengths and weaknesses (Warschauer, 1999, 2000). As these two cases

show, schools that develop an effective approach for promotion of academic literacy will be able to amplify their efforts with the use of new technologies.

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## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.system.2004.09.010.

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