Annotated Bibliography of Ubiquitous Computing Evaluations

-- Compiled by Dave Keefe, Phoebe Farag & Andy Zucker

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SRI International, Inc. • 1100 Wilson Blvd., Suite 2800 • Arlington, VA 22209-3915 • (703) 247-8540 • Fax: (703) 247--8493

This document provides information about evaluations and studies dealing with ubiquitous handheld or laptop initiatives, with special attention to K-12 mathematics and science education. Each entry includes reference information, followed by a brief project abstract.

Bartels, F. and L. Bartels (2002). Reflections on the RCDS laptop program after three years.[Online] Available: http://www.learningwithlaptops.org/files/3rd%20Year%20Laptop%20Prog.pdf

This report provides a perspective from the Rye Country Day School in NY State after more than three years of implementation. Provides useful resource information, primarily aimed at independent schools considering implementing one-to-one laptop programs. Authors are a couple who are both parents and technology consultants to the Rye Country Day School.

The authors use the term "virtual playground" as a metaphor for describing ways that ubiquitous computer access can be both engaging and enlightening.

- Mathematics education."*Geometer's SketchPad* is.. a virtual playground in mathematics education in the secondary schools. It is rapidly becoming an essential tool for teaching Geometry. Graphing programs [and spreadsheets] are increasingly being used for other math courses. *Mathematica* is being used with increasing frequency in the advanced Calculus classes."
- Science education. "Students can experience virtual worlds where the parameters that control natural forces and processes can be easily manipulated and the effects observed. …This allows for rapid experimentation with different designs… Real models should be built and tested but such models can be built with a much greater depth of understanding if there is first experimentation with virtual models." A second virtual playground type involves use of "computers and probes to do the dull and tedious work involved with data collection" allowing students to focus on problem solving, analysis and theory building.

The one-page project summary (p. 2) is an interesting model or template for reporting basic information about ubiquitous computing projects.

Burrill, G., Allison, J, Breaux, G, Kastberg, S., Leatham, K., & Sanchez, W. (2002). *Handheld graphing technology at the secondary level: Research findings and implications for classroom practice*. Dallas, TX: Texas Instruments. (TI publication CL2872.) [Online] Available: http://education.ti.com/us/global/promo/research.html

According to data obtained from a national survey, as of the year 2000 more than 80 percent of high school mathematics teachers used handheld graphing technology in their classrooms. In many secondary mathematics classrooms, every student has a graphing calculator. The authors of this publication, led by a former president of the National Council of Teachers of Mathematics, examined more than 180 published research reports and found 43 studies about handhelds that met their criteria for inclusion in the summary. Some of the major findings include:

- Teachers generally use handheld graphing technology as an extension of the way in which they have always taught and in accord with their beliefs about mathematics. Simply providing teachers with information about how the graphing calculator functions does not lead to significant changes in their teaching practice.
- Teachers' beliefs and teaching methods influence how students use technology. Students tend to use methods that are illustrated and preferred by their teachers. To be most effective, graphing calculator use needs to be thoughtfully integrated into curriculum and instruction.
- Students who use handheld graphing technology have a better understanding of functions, of variables, of solving algebra problems in applied contexts, and of interpreting graphs, compared to those who did not use the technology. At the same time, no significant differences in procedural skills were found between students who use handheld graphing technology and those who do not. But simply introducing technology is not enough—time spent using technology, the way in which the technology is used, the curriculum, and students' pre-existing knowledge and beliefs are among the critical factors affecting outcomes.
- Students who owned their own calculators more frequently exhibited a critical awareness of the calculator. (This and other findings reported in this document may have implications for other varieties of 1-to-1 computing initiatives.)

In spite of these patterns, research on the use of handheld graphing technology is not robust. Future research should describe the specific features of the context being studied, including the handheld graphing technology used, the content being studied, and the aspects of use that are being investigated. Research should also facilitate comparisons among different ways of using handheld graphing technology, not only between those who use it and those who do not. There is also a need for research to answer many specific questions, including some that relate to curriculum, such as what is the role of handheld graphing technology in learning mathematical content earlier than would have traditionally been done, or in learning content that is not part of the traditional mathematics curriculum?

Culp, K. M., M. Honey, et al. (2000). Local relevance and generalizability: Linking evaluation to school improvement. Menlo Park: SRI International. [Online] Available: http://www.sri.com/policy/designkt/chs.pdf

This paper reviews a perspective on evaluation of educational technology that emphasizes the importance of locally valid and locally useful research designs. More specifically, it builds on the authors' increased focus, over the past six years, on understanding how schools, school districts, and state and national educational authorities actually do move through the process of investing in and implementing educational technologies. This paper argues that effective evaluation must produce both research-based knowledge of what technological applications can work best in educational environments, and practice-based knowledge of how the technology integration process can best be designed to meet locally defined learning goals in schools.

The authors' evaluation "Design for the Future" proposes the creation of a network of "Technology Evaluation Teams." The thematic areas initially proposed for those teams

include Early and Middle Grades Science, asking the questions of how technology can effectively support critical thinking, writing, and interpretation across a wide range of content areas; and High School Science, addressing the question of how technology can support the analysis of complex systems and the pursuit of scientific inquiry.

Hill, J. R., T. C. Reeves, et al. (2000). Ubiquitous computing for teaching, learning, and communicating: Trends, issues & recommendations. [Online] Available: http://lpsl.coe.uga.edu/Projects/AAlaptop/pdf/UbiquitousComputing.pdf

The purpose of this white paper, which is based on the Athens Academy laptop project, is to describe the means and potential outcomes of creating a ubiquitous computing environment in schools. Ubiquitous portable computing is described with reference to three main activities: teaching, learning, and communicating. The next section of the paper is a description of a theoretical framework for establishing ubiquitous computing environments. The theoretical foundation section is followed by the paper's main section that is focused on trends and issues related to current and potential applications of ubiquitous computing. This section reviews the findings of some ubiquitous computing project studies internationally and in the United States. Some of these studies found that students used portable computers mostly for English, mathematics, and science content areas. The final section of the paper includes a discussion of the implications of the other sections as well as recommendations for establishing a ubiquitous computing environment.

Hill, J. R., T. C. Reeves, et al. (2001). Impact of portable technologies on teaching and learning: Year two report, University of Georgia, Department of Instructional Technology. [Online] Available: http://lpsl.coe.uga.edu/Projects/AAlaptop/

In the summer of 1999, faculty in the Department of Instructional Technology at The University of Georgia were contracted by technology leaders at Athens Academy to conduct a long-term evaluation of the use of portable technologies in their school. This document describes the results from year two of this four-year evaluation project. It begins with background information about the origins of the portable technologies and the highlights from year one of the evaluation effort (1999-2000). Next, it presents a brief overview of the primary project activities carried out during year two followed by a description of the evaluation activities conducted during year two (participants, data collection and analysis efforts). Next, there is a presentation of results from the data collection and a review of findings from year two. Observations revealed that the highest use of laptops occurred in two primary subject areas: English and science. Other core subject areas, history/geography and math, made use of the laptops, but not as extensively as English and science. Finally, it summarizes key points from the year two evaluation and makes recommendations for year three.

Hill, J., T. C. Reeves, et al. (2002). The impact of portable technologies on teaching and learning. Paper presented at the annual meeting of the American Educational Research Association, New Orleans. [Online] Available: http://lpsl.coe.uga.edu/projects/aalaptop/pdf/aa3rd/Year3ReportFinalVersion.pdf

This document describes the results from year three of this four-year evaluation project. The document begins with highlights from year two of the evaluation effort (2000-2001). Next, it presents a brief overview of the primary project activities carried out during year three followed by a description of the evaluation activities conducted during year three (participants, data collection and analysis efforts). Next, there is a presentation of results from the data collection and a review of findings from year three. Finally, it summarizes key points from the year three evaluation and make recommendations for year four.

There do not appear to be differences in roles/responsibilities in practice. However, both students and teachers continue to ask for such changes. It does appear that there are differences in the processes of learning that can be attributed to the laptops. The increased access to the Internet/Web has enabled an increase in use of resources in the classroom. Presentations have also increased, both by teachers and students. The core subject areas that showed highest use are English and geography. Teachers and students are extending how they think about resource use in the classroom. Further, they are thinking about new ways to represent the information once it is gathered and analyzed. While the data providing evidence of change in the area of affective implications is limited, evidence was found of a "leveling of the playing field." That is, there was an increase in the percentage of 7th and 8th graders at the end of the year who did not perceive that their peers knew more than they did. This was a significant change from the attitudes expressed prior to receiving the laptops when many students indicated that they felt their peers did know more than they did about the laptops. At the end of the third year, there was little or no evidence of quantitative differences in achievement and performance that could be directly attributed to the laptops. There are several instances of changes indicated via qualitative data, as described in the Best Practices section. However, it is important to note that direct attribution to the laptop for any changes in learning, particularly in terms of direct knowledge, is difficult as there are many other changes occurring in the environment at the same time (e.g., changes in the curriculum, changes in student population, new teachers). There is little or no evidence that changes in cognitive skills were occurring as of the end of the third year. There is some demonstration of media literacy skills in the 7th and 8th grade. Students and teachers are thinking differently about how to use information sources for learning.

Hounshell, P. B., S. Hill, and R. Swofford. (2002). Using laptop computers to improve the performance of minority students: A pilot project. *Journal of Science Education and Technology, 11*(1), 101-103. [Online] Available: http://www.ericse.org/CD1/CD/topics-edutech.htm

A school system and a university joined forces to improve the science and mathematics environment for local minority students with a program that utilized computer technology. The initiative involved individual students from all of the high schools in the Winston–Salem/Forsyth County (North Carolina) School System. In this initiative, Wake Forest University operated a two-week Summer Science and Math Experience for

minority students. During the two weeks, students worked intensively with computers and, at the end of the summer program, a laptop computer was loaned to each student for personal use during the school year. Through interviews and questionnaires, students overwhelmingly endorsed their involvement in the computer-oriented project, both the summer and academic year phases. They especially liked having access to the Internet (provided by the project), being able to use e-mail and chat rooms, and utilizing the information retrieval potential. Parents and teachers surveyed also praised the project, feeling that their students learned more as a result of being involved in project activity.

Honey, M. and A. Henriquez (2000). Union City New Jersey, American Youth Policy Forum. [Online] Available: http://www.aypf.org/compendium/C2S18.pdf

This summary examines the results of two simultaneous initiatives undertaken in Union City School District, New Jersey. In 1989, Union City was declared a special-needs district and was threatened with a take-over by the state. In response, the school district developed a five-year improvement plan, which included comprehensive curriculum reform, cooperative learning and teacher teams. This plan attracted Bell Atlantic-New Jersey, which was looking for a site to test a project for bringing technology schools and communities through telephone networks. In Fall 1993, Bell Atlantic initiated a pilot program at Christopher Columbus Middle School by supplying computers to the school and the homes of its seventh grade students and teachers. As the students advanced to high school, the company added support for participating teachers. The District later expanded the technology trial into a comprehensive school and community-network covering all eleven schools in the district. The network, known as Union City Online, was funded by the National Science Foundation.

Between 1989 and 1997, the combination of new curriculum, teaching methods and the infusion of technology, resulted in a statistically significant: decrease in the student-mobility rate, improvement in standardized test scores for elementary school students, and increase in test scores for middle school students. Standardized test score increases in math were 18 percentile points for elementary school students and 29 percent for middle school students. The pilot technology program helped to improve: communication among participants and overall performance for students at the pilot technology school. In 1995, Union City students scored 27 percentile points above students in other special needs districts on the Early Warning Test. As a result of the comprehensive reforms, the New Jersey State Department of Education ended its monitoring procedures and fully certified the Union City School District.

Laughbaum, E. D., Ed. (2000). Hand-held technology in mathematics and science education: A collection of papers. *Teachers teaching with technology* college short course program. Columbus: The Ohio State University. [Online] Available: http://www.math.ohio-state.edu/~elaughba/

This report is a collection of professional journal articles, conference presentations, and editor requested materials on the use of handheld technologies. Sections include the history and future of handheld technology, research, pedagogy using graphing calculators, pedagogy using computer algebra systems (CAS) calculators, applications in mathematics education using graphing calculators, applications in mathematics education

using computer algebra systems calculators, assessment with technology, and applications in physics education. The authors come from seven countries.

Light, D., McDermott, M. & Honey, M. (1999). Project Hiller: The impact of ubiquitous portable technology in an urban school. New York: Educational Development Center, Center for Children and Technology [Online] Available: http://www.union-city.k12.nj.us/innovations/studentp/projecthiller/report.html

For this project, the Union City Board of Education committed three years of funding to provide network-enabled desktop computers to over 60 students in Year 1. In Years 2 and 3, another 60 students from the incoming freshman class were to receive computers. CCT conducted a two year evaluation of the impact of home access in a context in which many of the initial challenges associated with urban school reform and technology integration have been overcome.

Outcomes claimed for the first year of research include:

Academic achievement for all. Cultural issues at Union Hill High School remain a problem. The goal is to emulate the results achieved at Emerson High where "The net result is that there's a culture at Emerson High School that says it's 'cool' to be smart and technologically savvy, and many students strive to achieve academically."

Teaching practices. Union Hill is proving to be an environment where teachers feel they must have tight control at all times.

Technology use. "Despite fairly high levels of comfort with and knowledge about computer and telecommunications technology, the use of these tools for instructional purposes is a long way from being integral to the curriculum."

Students' perceptions. Perceptions are mostly positive toward teacher expectations and their own motivations. Perceptions are least positive in terms of teacher caring or scaffolding if students are having trouble learning.

Project Hiller parents. Educational success is perceived as being important to Hiller parents. Parent support at meetings backs this up.

Light, D., McDermott, M. & Honey, M. (2000). Project Hiller: CCT second year report. New York: Educational Development Center, Center for Children and Technology [Online] Available: http://www.union-city.k12.nj.us/innovations/studentp/projecthiller/report2.html

Student learning. Changes in student activity range from increased use of the Internet as a research tool to email exchanges to multimedia presentations to desktop publishing to electronic fieldtrips to videoconferencing and web-zines.

Teacher learning. Practices and beliefs of teachers show higher use of long-term projects, group work and allowing students a greater role in planning classroom activities.

Teacher beliefs and practices. Teachers are demonstrating higher levels of trust in their students through expanding opportunities for students to investigate subjects that interest them.

Ubiquity. Cohort 2 participants display evidence that the iBooks are a basic item in their backpacks. This is having an impact on the school environment.

Examples of technology-supported learning activities in mathematics and science include:

Science education examples. "Students do multimedia presentations on different planets and present [these] to each other in class." Three science teachers in inclusion and general classes participated in an electronic fieldtrip to Glacier National Park. Science teacher uses laptops, email, PowerPoint and videoconferencing to enrich and strengthen Union Hill's on-going collaboration with a suburban New Jersey high school.

Mathematics education. Teacher is designing math projects using the Internet to find data, spreadsheets for analysis and PowerPoint to present the results. Two projects were swimming pools and cubic volume and exponential growth of bacteria.

Lowther, D., Ross, S., Morrison, G. (2001, June 25-27, 2001). *Evaluation of a laptop program: Successes and recommendations.* Paper presented at the "Building on the Future" NECC 2001: National Educational Computing Conference Proceedings, Chicago, IL [Online] Available: home.earthlink.net/~anebl/lowther.pdf

The overall purpose of this evaluation study was to determine the effectiveness of providing 5th and 6th grade students in Walled Lake Consolidated Schools (Tennessee) with access to laptop computers with regard to classroom learning activities, technology usage, and writing achievement. The Laptop Program classrooms were equipped with wireless access to the Internet and printers. The program also provided students and parents the opportunity to receive training on basic computer skills. The evaluation was structured around three primary research questions: (1) Is teaching different in a Laptop classroom? (2) Do students behave differently in a Laptop classroom? And (3) Do students achieve differently in a Laptop classroom? Data were gathered through classroom observations, student writing test scores, student surveys and focus groups, teacher surveys and interviews, and parent surveys and interviews. In this evaluation of the first year of the Laptop Program, the results were consistently supportive of beneficial impacts on students, teachers, and parents. Specifically, all three groups believed that the program was positively changing teaching and learning both at school and at home.

Lowther, D., Ross, S., Morrison, G. (2003). *When each one has one: The influences on teaching strategies and student achievement of using laptops in the classroom.* Memphis, TN: Center for Research in Educational Policy, The University of Memphis.

This study examined the educational impacts of providing 5th, 6th and 7th grade students with 24-hour access to laptop computers. Specifically it examined the impact of laptops on classroom activities, and student use of technology, writing achievement, and problem-solving. A matched treatment-control group design was employed in which

classes taught at the same grade levels in 5 participating schools served as the laptop (1 computer per student) and control (5+ computers per class) contexts. Results showed significant advantages for the Laptop group on five of the seven components of the problem-solving task.

Lukens, J. D., Feinstein, S. (2000). *Graphing calculators' impact on AP Biology*. Sioux Falls: Augustana College.

The central premise of this study was that the use of graphing calculator technology helped improve students' achievement in upper level biology courses. The populations studied included high school students in a block course entitled "AP Biology/AP Calculus" and students in a traditional AP Biology course. There appears to be a positive effect on student understanding and achievement on standardized exams when the graphing calculator is regularly used in an integrated science/math course. Students enrolled in the integrated Advanced Placement Biology/Advanced Placement Calculus block course where graphing calculators were a meaningful part of the curriculum performed significantly better on the Advanced Placement Biology exam when compared to students enrolled in the traditional Advanced Placement Biology where graphing calculators were not heavily integrated into the course. According to the authors, there appears to be a positive correlation between integrating graphing calculators in the higher level biology classes and the understanding and achievement of the students enrolled in the integrated course.

McKenzie Group, Ed. (2001). Handheld technology and student achievement: A collection of publications. Texas Instruments Incorporated.

This book contains published articles and doctoral thesis information for documents published from 1990 to 2001 related to the positive or negative effects of handheld technology on student learning and teaching techniques. The areas covered include handheld technology's effect on special populations, notably ESL and females, improvement in academic habits, information about topics other than student achievement, positive and negative effects in standards-based mathematics performance, and positive and negative effects in student improvement in upper level mathematics courses.

A related reference is at http://education.ti.com/us/global/promo/research2.html

McMillan, K., & Honey, M. (1993). *Year one of Project Pulse: Pupils Using Laptops in Science and English. A final report.* (No. 26). New York: Center for Technology in Education, Bank Street College. [Online] Available: http://www2.edc.org/NCIP/library/laptops/Pulse.htm

A year-long study was conducted with a class of 25 eighth graders, their English and science teachers, and the school computer supervisor at a school in Roselle (New Jersey). The structure and goals of the project, called PULSE, for Pupils Using Laptops in Science and English, are described. Research questions focused on the development of teachers' goals and practices and their relation to the technology, the development of project-based activities, the development of student writing skills, and the impact of local

telecommunications on teacher and student interaction. A high level of student and teacher motivation, the role of the teacher in facilitating student use of the technology, and an increase in technological competence were themes that were significant in the positive experiences of teachers and students. The portability of the laptops and the availability of integrated tool-based software were particularly useful in science education. Most of the students used the laptops as portable diaries to keep journals, write stories, and complete assignments. A holistic measure of writing scores for a randomly selected group of students indicated marked improvement in their ability to communicate persuasively, organize their ideas effectively, and use a broad vocabulary effectively. The local electronic bulletin board was heavily used by teachers, who also managed to leverage this project into a way of bringing other badly needed resources into their school. Seven figures and two tables present study findings. (Contains 21 references.)

Ricci, C. M. (1999). Program evaluation: The New York City Board of Education Community School District Six laptop project. Paper presented at the American Educational Research Association annual conference, Montreal, Canada. [Online] Available: http://metisassoc.com/Publications/aeralptp.pdf

The Laptop Project, in New York City's Community School District Six began in Fall 1996 with one pilot fifth grade class at Mott Hall School. The following fall (1997) saw the implementation of the laptop program in 17 classes throughout the district. The third phase began during the summer of 1998 with a laptop summer camp for an additional 500 children who were trained as 'student experts' and who facilitated the process of implementing the laptop computers into 81 additional classes during the 1998-99 academic year. From the beginning of the laptop project, Metis Associates, an independent research organization, conducted an evaluation of the implementation process and student, teacher, and parent outcomes. The early experiences of the pilot program are detailed in a March 1997 report entitled "Pilot Evaluation Report: Achieving Equity of Information Technology Access," available through Metis Associates and Community School District Six. This report summarizes the activities and events of the laptop project and presents student achievement data for the first and second years of the laptop initiative.

Preliminary findings indicate that students perceive great gains in their organizational and writing skills. They are more interested in school and are able to work more independently. The laptop teachers report that the quality of student work has improved and students seem more motivated and interested in learning. Student attitudes toward future goals and careers are extremely positive. Teachers also indicated that their role has become more of a knowledge 'facilitator' rather than knowledge 'provider.' Participation in the laptop program appears to have transformed teachers' instructional strategies to be more inquiry-based and student-centered. In terms of student achievement, as measured by standardized tests, the findings are less clear. Although laptop students were able to maintain their performance and in some cases even increase their achievement, the pattern of evaluation results across Mott Hall and the Project Smart Schools was not similar.

Rockman et al (1998). Powerful tools for schooling: Second year study of the laptop program. San Francisco. [Online] Available: http://www.microsoft.com/education/download/aal/research2.rtf

> In the Fall of 1996, Microsoft Corporation and Toshiba America Information Systems began a Laptop Pilot Program at 29 "pioneer" school sites across the United States. Participating students acquired and regularly used Toshiba notebook computers loaded with Microsoft Windows and Microsoft Office software. The pilot program was designed to demonstrate that providing every student within a classroom with access to "real world" business tools would produce substantial educational benefits by supporting learning anytime and anywhere.
>
> During the 1997-1998 school year, ROCKMAN ET AL tracked the experiences of teachers and students at selected pioneer schools during their second year of the Laptop Program. In these programs, participating students have full-time access to notebook computers both in school and at home. The second year study explores when and how the computers are used, their impact on teaching and learning, and participants' assessments of their experiences in the program. The findings, which include discussions of student use of laptops in the core content areas of English, science, math, social studies, and foreign language, point to significant learning and student and teacher accomplishments in skill development, applications of technology for schoolwork, and improved critical thinking.

Rockman et al (2000). A more complex picture: Laptop use and impact in the context of changing home and school access. San Francisco. [Online] Available: http://www.microsoft.com/education/download/aal/research3report.doc

> This report portrays the findings from a group of laptop schools and a smaller group of comparison schools. ROCKMAN ET AL conducted surveys of teachers and students, collected logs of computer use, gathered prompted writing samples, interviewed school administrators, and analyzed standardized test scores from a variety of state- and nationally-normed assessments. This third year report presents a more complex picture of the impact of a fully implemented school Laptop Program.
>
> Findings include: Access to technology has increased for all. Opportunities for individual access are still greater for Laptop students, and Laptop students consistently show deeper and more flexible uses of technology than their Non-Laptop matched groups. While Internet access for Laptop and Non-Laptop groups is identical at school and similar at home, Laptop students use the Internet more frequently and for longer periods of time. Laptop students spend more time doing homework on computers than do Non-Laptop students (on average per week). Both Laptop and Non-Laptop students use computers at home for a wider variety of tasks and subjects than they do at school. Laptop teachers show significant movement toward constructivist teaching practices. Laptop teachers show significant gains in how often they use computers for specific academic purposes. For both groups, the large majority of teachers who indicated a change toward more constructivist pedagogy also indicated that computers played a role in that change. Laptop students performed better on our writing assessment. Standardized test score comparisons were inconclusive. Comparison groups of Laptop and Non-Laptop students

show less clear differences in some areas than last year. Laptop students rate their confidence in computer skills more highly than Non-Laptop students. Laptop students' attitudes toward computers are more positive than Non-Laptop students'. Both Laptop and Non-Laptop students perceived specific benefits from computer use. While both groups are enthusiastic, Laptop teachers rate computers' effects on students more positively than Non-Laptop teachers. All the teachers surveyed are enthusiastic about the use of technology in the classroom.

Russell, M., Bebell, D., Cowan, J., & Corbelli, M. (2002). An AlphaSmart for each student: Does teaching and learning change with full access to word processors? Technology and Study Collaborative, Boston College. [Online] Available: http://www.bc.edu/research/intasc/studies/AlphaSmartEachStudent/description.shtml

This study emerged from a question "How does teaching and learning change when each student is provided with his/her own AlphaSmart?" What classroom practices change, if any, when the ratio of students to technology is increased from about 3 to 1 to 1 to 1? Specifically, what kind of changes occur in the way that students produce work, interact with each other, and interact with their teachers when they are provided full access to their own AlphaSmart.

Although this study was limited to three classrooms, the findings suggest that full access to word processors can have a positive impact on the use of technology in the upper elementary classroom in language arts, science, social studies, and mathematics. Given the relatively low cost of AlphaSmarts and the resulting benefits of providing each student with their own AlphaSmart found in this study, the authors strongly encourage technology leaders within schools as well as policy makers to consider policies and practices that promote full access to devices like the AlphaSmart in upper elementary classrooms. While access alone will not guarantee that technology will be used, for those teachers who either advocate or have actively attempted to use technology for instructional purposes, full access to word processors eliminates many of the managerial and technical issues that impeded regular use of technology in the classroom.

Schieber, C. E. (1999). *Information technology and education: An evaluation of a school laptop computer program.* Unpublished Doctoral Dissertation, Seattle Pacific University, Seattle, WA.

Society's entry into the Information Age has created great change in many institutions, including schools. One group of educators, constructivists, see the computer as a tool to help change the way teachers and students interact in the classroom. But empirical evidence has been mixed on the effectiveness of information technologies. The Copernicus Project was a three year, multi-district initiative designed to alter the education of students through creating a computer-rich environment. One district used a computer immersion program in which students owned and used laptop computers in daily instruction and on homework. The purpose of this study was to evaluate the influence of the laptop program on student writing and to explore the possible relationship between the use of computers and constructivist learning environments. Teachers in the program received training in the use of the laptops and constructivist pedagogy. Late in the second year of the program, writing samples from laptop and non-

laptop classrooms were compared using a six trait model. The writing scores between groups did not differ significantly. Environmental factors that would indicate the existence of a constructivist learning climate were measured using the My Classroom Inventory. MANOVA statistics indicated a significant deterioration in environmental factors over the course of the year in both groups of classrooms. There was no significant difference or interaction between the groups when comparing environmental factors, though the laptop classrooms showed greater deterioration in scores. Further research on the classroom impact of technology and constructivist theory could include gathering more formative information on teacher and student behaviors.

Siegle, D., Foster, Theresa (2000). Effects of laptop computers with multimedia and presentation software on student achievement. Paper presented at the annual meeting of the American Education Research Association (AERA), New Orleans, LA. [Online] Available: http://137.99.89.70:8001/siegle/Conferences/Siegle_Foster.htm

The purpose of this study was to investigate whether exposure to multimedia and presentation software on laptop computers influenced student achievement in a secondary level anatomy and physiology science course. Group A used laptop computers with A.D.A.M. (Animated Dissection of Anatomy for Medicine) multimedia software and PowerPoint presentation software during the first and second quarter of the 1997-1998 school year. Each of the students in Group A was given full-time possession of a laptop computer, including permission to take it home. Group B served as a control group and did not have access to the laptop computers, although MedWorks software and Internet were available on five workstation computers in the science classroom. Access was reversed for the second half of the year and Group B students used the laptops while Group A served as the control group. Instruction for both groups centered on lectures, lab activities, and open-ended projects. The authors claim the study demonstrated that students learned more when they had access to laptop computers, were exposed to multimedia software, and created projects with presentation software.

Silvernail, D., & Harris, W. (2003). *The Maine learning technology initiative: Teacher, student, and school perspectives mid-year evaluation report*. Maine Education Policy Research Institute. [Online] Available: http://usm.maine.edu/cepare/pdf/ts/mlti.pdf

The Maine Learning Technology Initiative (MLTI) provides every seventh and eight grade student and their teachers with laptop computers. MLTI also provides professional development and training to help teachers integrate the computers into their classroom instruction.

The goal of the Year One evaluation, which is being conducted by the Maine Education Policy Research Institute (MEPRI), is to help policy makers and practitioners assess to what degree the vision and goals of MLTI are being achieved. The Year One design is focused on students who entered seventh grade in September 2002, their teachers and schools.

The evaluation plan uses surveys and case studies in a mixed-methods approach to anwer three questions in three core areas. The core areas are Teachers and Teaching, Students and Learning, and Schools and Community. The three questions are:

1. How are the laptops being used?
2. What are the impacts of the laptops on teachers, students, and schools?
3. Are there obstacles to full implementation of the MLTI?

Teachers and Teaching. Early evidence indicates that most teachers report using laptops in lesson development and "classroom instruction." Teachers find their lessons are more extensive and up-to-date and provide opportunities to explore knowledge and information in more depth. *Lack of time* and *more professional development* are cited as barriers to further productivity.

Students and Learning. Study of this area indicates that MLTI has dramatically increased use of technology within classrooms for research, to complete assignments, create projects, and communicate with teachers and other students. Student engagement is also impacted positively. Among students responding to the evaluators' survey, 84% reported using their laptops for science classes, and 64% used the laptops for mathematics classes.

School and Community. Early evidence of the impact of MLTI indicates positive changes in student focus and interest in school.

The evaluation team concludes that the evidence to date indicates that significant progress has been made in implementing the MLTI goals to:

> "...transform Maine into the premier state for utilization of technology in kindergarten through grade 12 education, in order to prepare students for a future economy that will rely heavily on technology and innovation."

Sivin-Kachala, J. and E. R. Bialo (2000). Research report on the effectiveness of technology in schools. Washington, D.C., Software & Information Industry Association. [Online] Available: http://www.siia.net

Examines the effects of technology on student achievement, student self-concept and attitudes about learning and teacher-student interaction in the learning environment. Reports on the effects of software design characteristics on student achievement, as well as recent technologies, instructional decisions, special populations and learning environment characteristics.

Stevenson, K. R. (1998). *Evaluation report - year 2: Schoolbook laptop project* (No. 2). Beaufort: University of South Carolina Department of Educational Leadership and Policies. [Online] Available: http://www.beaufort.k12.sc.us/district/ltopeval.html

Year 2 of the evaluation of the Laptop Notebook Project in middle schools of the Beaufort County School District focused on academic outcome measures, particularly the

MAT7, a nationally standardized achievement test. The test scores of the 1997/98 seventh graders who were completing the second year of using the laptops in their respective school settings were studied and compared to those of their peers not using the laptops. In addition, the pre-project fifth grade scores (1996) of both groups (laptop and non-laptop users) were compared to determine if differences existed before laptops were introduced. Finally, an ancillary analysis was done to see if school attendance was related to use of laptops. Findings included: Seventh graders participating for two years in the laptop project significantly outscored their non-participating peers on the MAT7. However, significant differences in achievement between the two groups existed before the project. Seventh graders who have participated in the laptop project for two years tended to maintain their level of academic achievement over time, while non-participants experienced a decline in standardized achievement level. Students who were laptop participants for two years and who were on free and reduced lunch benefited most from the project. Their average standardized scores actually increased from fifth to seventh grade. In fact, by the end of the second year, these students were scoring as well as students not on free or reduced lunch who were not laptop participants. Students who were not laptop participants and who were on free and reduced lunch had the greatest declines in academic achievement over the two year period. Participation in the laptop project was associated with fewer days absent and fewer tardies. Students with laptops attended school more regularly and scored better on achievement tests.

Vahey, P. and V. Crawford (2002). Palm education pioneers program: Final evaluation report. Menlo Park, CA, SRI International. [Online] Available: http://www.palmgrants.sri.com/PEP_Final_Report.pdf

The goals of the Palm™ Education Pioneer (PEP) program were (1) to determine whether classroom teachers find handheld computers a useful educational tool, and (2) to aggregate the knowledge base of a large set of teachers using handheld computers in their classroom.

This, the final report on the PEP program, is intended to provide information to those interested in the benefits and drawbacks of handheld computers in the classroom. This report is based on data collected from the 102 Classroom Teacher Awards during the 2001-2002 academic year. All PEP awards were granted as part of a competitive program. PEP awardees are talented, innovative teachers who collectively have integrated handheld technology into a wide range of instructional activities. PEP teachers were overwhelmingly positive about the use of handheld computers in their classrooms. Approximately 90% of PEP teachers stated that handhelds are an effective instructional tool; that handhelds have the potential to have a positive impact on students' learning; and that they will continue to use handhelds in the future. Although teachers across all grade levels were positive about the use of handheld computers in their classroom, elementary school teachers were more positive than middle and high school teachers. Teachers who used handhelds for science-based curricula or for writing-based activities found handhelds most effective, although handhelds were found to improve learning activities across many curricular topics and instructional activities. PEP teachers found that the key benefits to students were increased time using technology, increased student motivation, increased collaboration and communication, and benefits from having a

portable and accessible personal learning tool. Key drawbacks included inappropriate use (especially of beaming), technology management issues (particularly synchronization issues), usability issues (particularly using the Graffiti software program for long text input), and equipment damage. PEP teachers reported that having the appropriate software and peripherals was key to the success of their handheld implementation. The use of probes was considered vital to most science-related curricula, and the use of keyboards was considered vital to extended writing assignments. Nearly all teachers reported that additional software was essential to maximizing the benefits of handhelds for learning.