Berkshire Wireless Learning Initiative

Phase 1 Final Evaluation Plan

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Abstract

The three-year evaluation of the Berkshire Wireless Learning Initiative (BWLI) will examine the educational effects of a 1:1 wireless laptop computer program involving more than 2,300 middle-school students and teachers in Pittsfield and North Adams, MA.

Despite growing interest and investments in 1:1 laptop programs, there is a serious lack of empirical evidence regarding the outcomes and impacts of 1:1 computing on teaching and learning. Those studies that do exist generally suffer from one or more of the following problems:

- Lack of baseline data against which outcomes can be compared;
- Lack of comparison sites that do not have 1:1 laptop programs;
- Lack of student achievement outcome measures; and
- Failure to examine the impact of a program over multiple years.

The BWLI evaluation provides a unique opportunity to explore and fully document the effects of 1:1 computing on teaching and learning using a variety of methodological techniques to overcome such problems. Boston College researchers will design and implement an evaluation plan that assesses the immediate impacts of technology on classroom practices, using both qualitative and quantitative approaches. These methods will include establishing baseline data and measuring changes. The study will also compare Berkshire County's results to four matched control group schools that do not have 1:1 laptop computing.

Specifically, the study will measure how successfully the program achieves the following targeted outcomes:

- Enhanced student achievement as shown through test scores, grades, and assessments;
- Improved student engagement as shown through attendance, disciplinary data, and classroom participation;
- Fundamental changes in teaching strategies, curriculum methods, and classroom management; and
- Enhanced capabilities among students to conduct independent research, and collaborate with peers.

The evaluation will commence prior to deployment of the student laptops and the final report will be submitted to the Commonwealth in the fall of 2008.

Background and Introduction

> "The transition to pervasive computing has profound implications for education and may represent as great a paradigm shift as the invention of writing itself." *Bull, Bull, Garofolo, & Harris, 2002, p. 1*

> "The great preponderance of technology evaluation studies to date depend upon relatively weak survey measures of implementation—one-item scales, for instance…" *Baker & Herman, 2000, p. 7*

Over the last 20 years, substantial investments have been made in educational technology. As a consequence of these major investments in technology, the average student-to-computer ratio has decreased dramatically over a twenty-year period from 125:1 in 1983, to 9:1 in 1995, to 6:1 in 1998, and 4:1 in 2002 (Market Data Retrieval, 1999; Education Week, 2003). While access to computers has increased, teachers and students in traditional school environments generally report using computers in schools for only a small amount of time each day, with the least amount of use occurring in science and mathematics classes (Bebell, Russell, & O'Dwyer, 2004; Russell, Bebell, O'Dwyer, & O'Connor, 2003; Ravitz, Wong, & Becker, 1999). Despite the many ways in which computers can be distributed within schools (e.g., in labs, libraries, or on shared carts), some observers theorize that the disjuncture between the dramatic increase in the presence of computers in schools and the relatively stagnant amount of use results in part because student-to-computer ratios have not yet reached a stage at which the technology is ubiquitous (Bull, Bull, Garofolo, & Harris, 2002; Papert, 1996; Rockman, 1998).

Both proponents and opponents of educational technology agree that the full effects of technology in schools will not be fully realized until the technology is no longer a shared resource (Oppenheimer, 2003; Papert, 1992, 1996). Currently, a new reality has begun to emerge as thousands of students and teachers have been provided with their own laptop computers. Today, Henrico County School District in Virginia is in the fourth year of a district-wide 1:1 laptop program for grades 6 through 12 and the state of Maine is in the third year of a state-wide laptop program which provides a laptop to each student in grades 7 and 8. Similar 1:1 laptop initiatives are being launched in New Hampshire, Texas, Georgia, Louisiana, California and Michigan.

Past program evaluations suggest several positive outcomes from 1:1 laptop initiatives including: increased student engagement (Cromwell, 1999; Rockman, 1998; MEPRI, 2003), decreased disciplinary problems (Baldwin, 1999; MEPRI, 2003), increased use of computers for writing, analysis and research (Cromwell, 1999; Baldwin, 1999; Guignon, 1998; Russell, Bebell, & Higgins, 2004), and a movement towards student-centered classrooms (Rockman, 1998). Baldwin (1999) also documented effects on student behaviors at home such that students reported spending less time watching television and more time on homework. Similarly, Russell, Bebell and Higgins (2004) report that students' academic use of computers at home occurred more frequently when students were provided with their own laptops. In addition, an evaluation of the Maine laptop program (Silvernail & Lane, 2004) and of a laptop program in Andover, Massachusetts (Russell, Bebell, & Higgins, 2004) provide evidence that substantially more use of laptops is occurring in science and mathematics classes in comparison to what has been found in studies that focus on non-1:1 laptop settings (Ravitz, Wong, & Becker, 1999; Russell, O'Brien, Bebell, & O'Dwyer, 2003).

However, despite growing interest in and excitement about 1:1 computing, there is a lack of sufficient, sustained, large-scale research/evaluation that focuses on teaching and learning in these intensive computing environments (Schacter, 1999). Specifically, there is a lack of evidence that relates use of technology in these 1:1 settings with student achievement. As discussed in greater detail, the methodological and psychometric challenges in such work are partially responsible for this lack of research.

In January 2004, the Massachusetts Legislature enacted the Economic Stimulus Bill initiating the Berkshire Wireless Learning Initiative. The Berkshire Wireless Learning Initiative (BWLI) is a pilot program being developed in Berkshire County to evaluate a 1:1 approach of using laptop computers and wireless communication to transform teaching and learning across four Berkshire County (MA) middle schools. As a pilot program, the Berkshire Wireless Learning Initiative is making evaluation a focal point of its work, with the goal of providing meaningful data to both Berkshire County and other communities.

The Berkshire Wireless Learning Initiative provides a unique opportunity to explore and fully document the effects of 1:1 computing on teaching and learning using a variety of methodological techniques that overcome many common methodological challenges and shortcomings. A research team led by Damian Bebell and Mike Russell of Boston College's Technology and Assessment Study Collaborative (inTASC) will implement an evaluation plan that assesses the immediate impacts of technology on classroom practices, using both qualitative and quantitative approaches. These methods will include establishing baseline data and measuring changes. The study will also compare Berkshire County's results to four control group middle school that do not have 1:1 laptop computing.

Specifically, the evaluation of the BWLI will measure how successfully the program achieves the following targeted outcomes:

- Enhanced student achievement as shown through test scores, grades, and inTASC developed assessments;
- Fundamental changes in teaching strategies, curriculum methods, and classroom management;
- Enhanced capabilities among students to conduct independent research, and collaborate with peers; and
- Improved student engagement as shown through attendance, disciplinary data, and classroom participation.

The three-year evaluation study represents the first truly comprehensive and in-depth examination of the impacts of 1:1 computing on student achievement to date.

Psychometric and Methodological Issues

Over the past two decades, hundreds of studies have examined instructional uses of technology. As Waxman, Lin, and Michko (2003), Goldberg, Russell, and Cook (2003), and O'Dwyer, Russell, Bebell, and Seeley (2004) report, many studies of educational technology suffer from one or more shortcomings. Specifically, this research is often limited by (1) the way in which students' and teachers' technology use is measured, (2) a lack of prior student achievement measures or comparison groups, and (3) a reliance exclusively on paper based test in a high-tech classroom environment. In the following pages, we detail the broad methodological concerns that

pose unique challenges to evaluating 1:1 technology programs as well as detail techniques and methods for overcoming these challenges for the BWLI evaluation.

Measuring Technology Use:

While there is a strong desire to examine the impact of technology on student achievement, research suggests that the impacts on learning must first be placed in the context of teacher and student technology use (Bebell, Russell, & O'Dwyer, 2004). In other words, before the outcomes of technology integration can be studied there must be (1) a clear understanding of how teachers and students are using technology in 1:1 environments, and (2) valid and reliable measures of these uses must be developed. Instead of developing measures of use, some research studies that examine the relationship between achievement and technology use assume that teachers' and students' access to technology is an indicator of technology use.

As an example, Angrist and Lavy (2001) used the student-to-computer ratio as a proxy for technology use. Moreover, schools in which one computer is available for every ten students were designated as high-use settings. The results of the study showed no impact of the technology upon mathematics achievement. However, it is not surprising that students' access to such limited technology resources would have a negligible impact on student achievement. In contrast, Wenglinksi (1998) employed two measures of technology use. The first measure focused specifically on use of technology for simulation and higher-order problem solving and found a positive relationship between use and achievement. The second measure employed a broader definition of technology use and found a negative relationship between use and achievement. Thus, depending upon whether and how one measures use, the relationship between technology use and achievement seems to differ. Moreover, it is important to note that recent research suggests that there are a variety of ways in which students and teachers use technology and these uses are not equivalent to access (Bebell, O'Dwyer & Russell, 2004; O'Dwyer, Russell, & Bebell, 2004). In the current study the authors will rely upon technology use instruments that have been developed and validated through the process of extensively surveying over 4,000 Massachusetts teachers and over 12,000 Massachusetts students (Bebell, O'Dwyer & Russell, 2004).

In addition, recent research demonstrates the utility of examining the relationship between these specific measures and performance on sub-scale test scores that are aligned with these measures. Specifically, O'Dwyer, Russell, Bebell and Seeley's (2004) analyses of the relationship between technology use for language arts and performance on the fourth grade Massachusetts Comprehensive Assessment System (MCAS) Language Arts test indicate that higher levels of computer use for writing in school is statistically significantly associated with higher performance on the writing sub-test, but not with the Reading Comprehension or Language sub-tests. Conversely, higher levels of computer use to create presentations in school had a statistically significant negative relationship with performance on the Writing sub-test, but no relationship with performance on the other two sub-tests. Finally, higher levels of students' recreational use of computers at home had a statistically significant negative relationship with performance on the Reading Comprehension sub-test, but not the other two sub-tests. In addition, similar results were found in a 2004 analysis of the 4th grade MCAS math test (Russell, O'Dwyer, Bebell & Seeley, 2004). Findings from these studies demonstrate the utility of both measuring specific uses of technology in and out of school and of examining the relationship between these specific uses and performance on each construct measured by a standardized test.

Lack of Prior Achievement Measures or Comparison Groups:

When examining the impact of 1:1 technology use on student learning, it is critical that measures of students' prior achievement are collected or data are similarly obtained from students in comparable non 1:1 settings. The importance of using a measure of students' prior achievement is especially relevant when comparisons are made among students who are not randomly assigned to experimental or control groups. Without measures of prior achievement, policy makers cannot be clear if differences in student achievement are a result of participation in a technology program or an artifact of non-random selection. In the current study, students' prior levels of achievement will be taken from prior administrations of the Massachusetts Comprehensive Assessment System (MCAS).

Paper Versus Computer Based Assessments:

In addition to the shortcomings of using existing standardized tests to examine effects of technology use on student achievement, Russell (1999) also argues that many of today's paper-based standardized tests may be underestimating the performance of students who are accustomed to working with technology simply because they do not allow students to use these technologies when being tested. Through a series of randomized experiments, Russell and his colleagues provide empirical evidence that students who are accustomed to writing with computers in the classroom perform between 0.4 and 1.1 standard deviations higher when they are allowed to use a computer when performing tests that require them to compose written responses (Russell, 1999; Russell & Haney, 1997; Russell & Plati, 2001). Becker (as cited in Kirkpatrick & Cuban, 1998) also maintains that achievement tests fail to accurately capture technology's role even when gains are achieved and notes that, "When standardized test scores rise, it's difficult to discern whether the rise was due to the students' work with computers or another influence" (p. 6).[1] Together, such shortcomings of using standardized tests confound efforts to examine the direct effects of technology use on student learning.

Thus, when using standardized tests, or any measure of student achievement, it is important that the constructs measured by the instrument are aligned with the constructs developed through students' uses of technology and that the form of the test (e.g., paper- or computer-based) does not add construct-irrelevant variance.

Given what we believe is a lack of appropriate tools and capacity for evaluating the impacts of 1:1 computing environments on achievement, a component of the evaluation activities we propose to undertake focuses on the development and use data collection tools that will shed light on the impact of technology use in the four Massachusetts schools that are participating in the BWLI. Specifically, we have developed computer adaptive technology use surveys for both teachers and students that yield measures of technology use that capture specific, rather than general, technology uses in technology-enabled language arts, mathematics, science, and social studies classrooms. In addition, to measure the effects of 1:1 laptop use, we will examine students' MCAS scores, writing test performance where technology use is allowed during testing, grades, attendance, behavioral indicators, and attitudes towards school and learning.

[1] Pedagogical beliefs and practices have been shown to interact with technology use to affect student learning. Thus, it is important to consider both pedagogical practices and specific technology use when examining the relationship between technology use and learning outcomes. For this reason our adaptive survey will include a section that measures teachers' pedagogical beliefs and practices using item sets that have been validated through prior research (Becker, 1999; Russell, O'Dwyer, Bebell, & Miranda, 2003).

Conceptual Approach

The current project aims to empirically investigate of the effect of a 1:1 laptop program on teaching and learning across the four middle schools participating in the BWLI. Generally, the evaluation aims to capitalize on the research opportunities inherent in the three-year technology deployment of the BWLI schedule. Examining different grade levels through a series of pre/post and comparison examinations encompass the evaluation design mirroring the deployment of 1:1 student laptops at the four BWLI schools. In addition, four comparison schools have been identified and have agreed to participate in data collection procedures providing a control group of over 2,000 non-1:1 students from complementary middle schools.

The evaluation design will provide meaningful data about the immediate impacts of the technology on classroom practices. The evaluation design also addresses a number of the more far-reaching goals of the program by examining the impacts of the technology on student achievement and on more nuanced educational objectives using both qualitative and quantitative approaches. Specifically, the evaluation team will use a series of teacher surveys, teacher interviews, student surveys, student drawings, analysis of school records, and qualitative classroom observations to document and track the impacts of 1:1 computing on teaching and classroom practices. Student achievement measures will also be examined through individual student MCAS performance in the three participating public BWLI schools and four comparison sites through a non-equivalent comparison group study. In addition, a technology-enabled writing assessment (adapted from a publicly released MCAS or NAEP item) will be used to document the impacts of specific technology use on student learning across the four schools as well as a sample of the comparison sites. Finally, to provide insight into the effect of professional development on teachers' beliefs, skill, and use of technology and to examine technical components of the program that may interfere with effective use, teacher surveys will include several items that have been used in past research and which focus specifically on these issues.

The classroom experiences of teachers and students will be specifically documented through adaptive computer-based surveys, student drawings, as well as through structured teacher interviews and a series of classroom observations in selected 1:1 classrooms. Participating teachers will be surveyed at different stages of the program implementation to evaluate changes in technology use in and out of the classroom, teachers' comfort level with technology, and teachers' attitudes toward technology. The student survey includes measures of students' access to technology in school, use of technology in school across subject areas, personal comfort level with technology, access to technology at home, and various uses of technology at home. Embedded in the student survey will be a technology fluency assessment that will be used to examine the effects of BWLI participation on students' technology knowledge and skills. As demonstrated in our previous 1:1 evaluation and research, student drawings also provide a unique and surprisingly valuable perspective on the impacts of technology as perceived by the students themselves (Russell, Bebell and Higgins, 2004; Russell, M., Bebell. D., Cowan, J., & Corbelli, M.,2003). Additionally, selected 1:1 classrooms will be selected and a trained qualitative researcher will observe teaching and learning throughout the program.

In short, to effectively evaluate the numerous program goals and components of the BWLI a wide variety of perspectives and methodologies must be utilized. To be most efficient, the evaluation capitalizes on the deployment schedule of the student laptops providing a series of naturally occurring pre/post comparisons by grade level. Although the present document is chiefly concerned with detailing the specific attributes of the evaluation methodology and timeline, it is

important to consider that there is some inherent flexibility designed into any effective evaluation plan. This flexibility and adaptability allow the research staff to respond to unique or acute issues that arise throughout the project and best meet the needs of the project stakeholders and participants.

BWLI Deployment

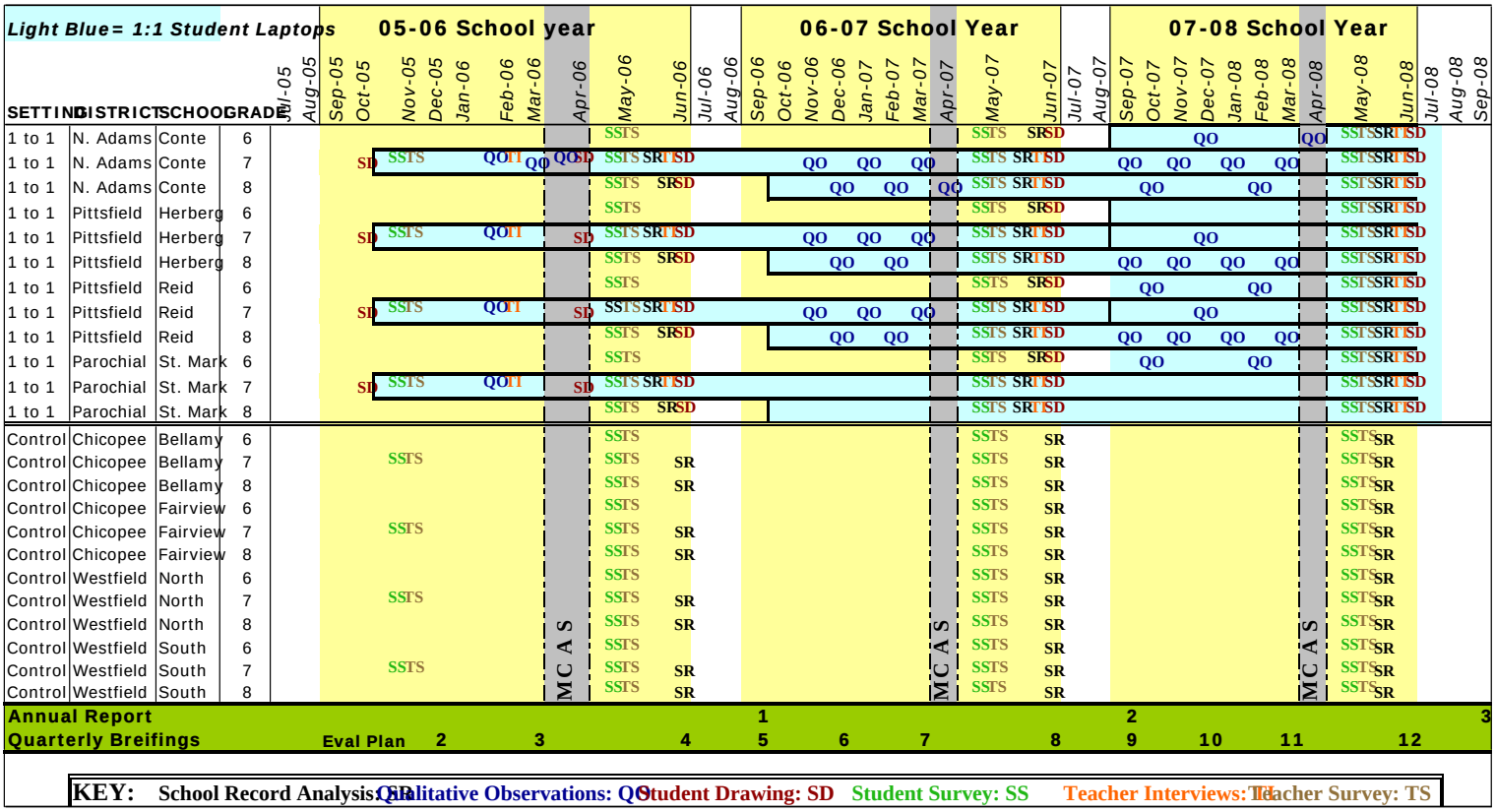
As previously discussed, the current evaluation seeks to capitalize on the deployment schedule of the BWLI program. At the time of this evaluation plan (October, 2005), 6th, 7th, and 8th grade teachers across the four BWLI schools should all have their Apple iBook laptop computers available. In addition, teachers are participating in technology integration professional development opportunities. Apple Computer technicians are also working with district leaders to install the wireless school networks and system servers, which aim to be operational by November 2005. It is expected that by the time of the first data collection in the BWLI schools (Nov./Dec. 2005), all of the participating staff should have their new laptop computers, some training, as well as wireless schools.

As currently projected, 7th grade students across the four BWLI schools should be receiving their new laptops by December 2005. The 7th grade students will use their laptops throughout the remainder of the 2005-2006 academic year. The laptops will then follow the students into 8th grade for the entire 2006-2007 academic year and the new 7th grade students will be provided laptops in the first months of the new school year to use throughout the year. Thus, by year 2 of the study, all 7th and 8th grade students and teachers will be in a 1:1 learning environment. With the beginning 2007-2008 academic year, all middle school students (6th, 7th, and 8th) across the four BWLI schools will have access to 1:1 computers for the final year of the study.

Evaluation Overview (Broad Chronological Approach)

Using both pre/post measures as well as comparison schools, the BWLI evaluation will follow the deployment of the student technology and examine each grade level separately over the three years of the study. Figure 1 illustrates the participating BWLI and comparison schools, the 1:1 student deployment, the evaluation timeline, the various evaluation components and the general structure of the proposed research. A chronological overview of the evaluation is then followed by a thorough discussion of the specific methodological approaches to be used throughout the study.

Figure 1: Overview of the Participants, Deployment and Evaluation for the BWLI



Pre-Year 1 Data Collection (September-November 2005)

Researchers will use the months before year 1 data collection to continue compiling school lists of participating staff and coordinating data collection procedures. Adaptive online surveys will be created using well established and previously validated measures of various teacher and student technology uses across the curriculum as well as scales of attitudes, confidence, access, professional development experiences, etc. This process will include updating and customizing existing survey instruments through informal classroom observations, interviews, as well as meetings with project leaders and stakeholders. These surveys will include a newly devised scaling method that allows true ratio measurement of technology usage in and out of school. In addition, a collaborative relationship between Boston College and the Massachusetts College of Liberal Arts (MCLA) will continue to be further developed with a goal of identifying and training undergraduate student candidates to carry out the qualitative classroom observations.

Year 1 (2005-2006 academic year)

The first year of the BWLI program will see all (6th, 7th, and 8th) teachers receiving laptops as well as additional technology resources (professional development, wireless classrooms, etc.). In addition, 7th grade students across the four BWLI schools will receive 1:1 laptops in late November 2005.

The first year of the BWLI program evaluation will focus resources on documenting the initial impacts and effects of 1:1 computing across the 7th grade participants and establish baseline measures of non-1:1 technology practices in grades 6 and 8.

As Figure 1 illustrates, teacher and student surveys will be given to 7th grade students and faculty across the four BWLI sites as well as the four comparison group sites in November 2005 and again near the end of the school year (May/June 2006). In addition, 6th and 8th grade teachers and students will also participate in a year-end survey across all BWLI and comparison group schools. School records including disciplinary reports and attendance figures will be collected across the BWLI and comparison group sites at the completion of the school year and compared to historic rates (pre 1:1) for 7th grade. 8th grade school records will also be collected to establish baseline data for later examination. A study of the impact of 1:1 computing and student achievement will employ both 7th grade student level MCAS data as well as an inTASC created writing assessment for both BWLI and comparison classrooms. Shifts in how 7th grade students and teachers perceive learning in a 1:1 setting will be addressed through a pre/post drawing exercise across the four BWLI schools. Additionally, teacher interviews will be conducted midway through the school year and again near the end of year 1 with 7th grade BWLI faculty. Lastly, trained classroom observers will selectively visit BWLI classrooms to begin documenting the variety and scope of technology uses occurring in the 1:1 classrooms.

Year 2 (2006-2007 Academic Year)

The second year of the BWLI program finds all (6th, 7th, and 8th) teachers with laptops for their second school year. 7th grade students across the four BWLI schools will bring their 1:1 laptops with them into 8th grade and the incoming class of 7th grade students are slated to receive 1:1 laptops by November 2006.

Year two of the BWLI program evaluation focuses chiefly upon exploring the impacts of 1:1 computing on teaching and learning through the naturally occurring pre-post condition present for 8th grade 1:1 computing between year 1 (baseline) and year 2 (1:1 computing). In addition, 7th grade student and teacher practices will continue to be documented throughout their second year of 1:1 computing as well as the thorough documentation of baseline (non 1:1) data for grade 6.

As Figure 1 illustrates, all BWLI and comparison group teachers and students will participate in surveys near the end of the school year (May/June 2007). School records including disciplinary reports and attendance figures will be collected across the BWLI and comparison group sites at the completion of the school year and compared to historic rates (pre 1:1) for 7th and 8th grade. 6th grade school records will also be collected to establish baseline data for later examination. A study of the impact of 1:1 computing and student achievement will employ both 7th and 8th grade student level MCAS data as well as an inTASC created writing assessment for both BWLI and comparison classrooms. In addition, samples of teachers in active 1:1 settings (7th and 8th grade) will be selected to be interviewed by research staff near the end of the 06-07 academic year. Lastly, trained classroom observers will continue visiting 7th and 8th grade classrooms documenting the variety and scope of technology uses occurring in 1:1 settings.

Year 3 (2007-2008 Academic Year)

The third year of the BWLI program finds all (6th, 7th, and 8th) teachers with laptops for their third school year. 7th grade students across the four BWLI schools will bring their 1:1 laptops with

them into 8th grade and the incoming class of 6th and 7th grade students are slated to receive 1:1 laptops early in the 2007-2008 academic year.

As Figure 1 illustrates, all BWLI and comparison group teachers and students will again participate in surveys near the completion of the school year (May/June 2008). School records including disciplinary reports and attendance figures will be collected across all of the BWLI and comparison group sites at the completion of the school year and compared to baseline (pre 1:1) conditions. A study of the impact of 1:1 computing and student achievement will employ both student level MCAS data across all middle school grades as well as an inTASC created writing assessment for both BWLI and comparison classrooms. In addition, samples of teachers across 1:1 settings will be selected to be interviewed by research staff near the end of the 07-08 academic year. Lastly, trained classroom observers will continue visiting 1:1 classrooms documenting the variety and scope of technology uses in ubiquitous computing settings.

To be most effective, the BWLI evaluation needs to be sensitive and flexible enough to capture any novel results or unexpected findings that occur during the three-year implementation of the BWLI. It is impossible to predict the specific needs or desires of the project stakeholders by the second or third year of the project. As such, what is described in this document provides the basic data collection procedures used to address the core research and evaluation questions. It is expected that, as needs arise, the evaluators will be well poised to address such inquires as they may occur.

Timeline and Reporting

It is expected that the BWLI evaluation will commence data collection just prior to the 7th grade student deployment of 1:1 computers in November 2005 and follow the implementation of the technology program through the 2007-2008 school year. The final evaluation report will be issued in September 2008[2]. In total, Boston College will provide evaluation services for approximately 38 months.

As depicted in the lower band of Figure 1, quarterly reports will be issued at three-month intervals beginning in September 2005 to provide a formal feedback loop for project leaders, participants, and stakeholders. The current document (Formal Evaluation Plan) will serve as the first quarterly evaluation report. In addition, annual progress reports will detail all project findings to date beginning September 2006.

Methodological Approaches

In the following paragraphs each of the methodological approaches is further detailed and explained in relation to the BWLI evaluation. Through this multi-method and multi-faceted evaluation design, we aim to document the effects of the 1:1 initiative on teaching and learning practices, as well as learning outcomes, while also providing insight into some of the conditions (i.e., professional development and technical issues) that support or impede effective use.

Throughout the different data collection procedures described below, we aim to thoroughly examine various factors across content areas and across a variety of groups, including high and low income students and high and low performing students. Since one goal of the program is to

[2] The final report deadline is assuming that MCAS results will be released by the state on schedule.

increase equity among students, we will examine the extent to which the amount of use of technology for learning becomes more equal over time.

Teacher Survey

All participating BWLI and comparison group teachers will be surveyed at least once each year throughout the BWLI program via a web-based adaptive questionnaire. In contrast to the current web-based surveys used to evaluate technology use, which present all respondents with a limited set of items in a linear manner, our survey will adapt the presentation of items based upon the teachers' responses to each item. Just as adaptive achievement tests tailor test items to efficiently provide an accurate estimate of an examinee's ability (Wainer, 1990), the adaptive surveys will tailor the items presented to a given student or teacher in order to probe the specific ways and frequency with which laptops are used to develop student learning. Since teachers across multiple settings may potentially use laptops in very different ways, an adaptive survey approach will enable us to probe the specific ways in which teachers use technology without requiring teachers to respond to survey items that are largely unrelated to these uses. Through an adaptive survey, a more complete and accurate descriptive understanding of how and when laptops are being used will be acquired. Moreover, due to the adaptive nature of the survey, teachers will not be presented with sets of items that are *unrelated* to the ways in which they use laptops, thus decreasing time required to complete the survey, decreasing fatigue, and increasing the accuracy of information provided for items that are *related* to their use of laptops.

The teacher survey will include universally shared item sets dedicated to capturing the variety and extent of teachers' technology use, teachers' attitude toward technology, teaching, and learning, as well as teachers' beliefs of student motivation and engagement. For each grade level, at least one pre and one post laptop teacher survey will provide documentation of the impacts of the 1:1 computing on teacher practices, beliefs and attitudes. It should also be noted that the teacher survey will include a section that focuses on the professional development they have received related to the use of laptops, the extent to which they have applied what they learned, and additional support that they require. Similarly, a section of the survey will focus on technical aspects of the program (e.g., slow network, difficulty accessing on-line materials, timeliness of technical support, etc.) that may be impeding the full effects of the initiative. In addition, as the evaluation unfolds additional teacher surveys may be implemented to cover specific issues or further clarification.

Student Survey

All participating BWLI and comparison group students will be surveyed via a web-based adaptive questionnaire at least once per year during the duration of the BWLI program. Like the adaptive teacher survey, the student survey will adapt the presentation of survey items based upon the students' responses to each item as previously described.

The student survey includes measures of students' access to technology in school, use of technology in school across subject areas, personal comfort level with technology, attitudes towards technology, access to technology at home, and various uses of technology at home. In addition, the student survey will include a short series of interactive tests to measure students' technology fluency skills and abilities.

For each grade level, at least one pre and one post laptop student survey will provide documentation of the impacts of the 1:1 computing on teacher practices, beliefs and attitudes.

Student Drawing

As demonstrated in previous 1:1 evaluation and research, student drawings provide a unique and surprisingly valuable perspective on the impacts of technology as perceived by the students themselves (Russell, Bebell & Higgins, 2004; Russell, Bebell, Cowan & Corbelli, 2003). Although student drawings are an unusual tool for collecting information about students and their classrooms, student drawings provide a rich descriptive examination into students' perspective that is often neglected in more traditional data sources. To triangulate information provided by the teacher surveys, student surveys, and teacher interviews about how technology is applied in writing, all students in 1:1 settings will participate in a pre and post 1:1 drawing exercise.

Specifically, students will be asked to draw a picture of themselves writing during the school day. Specific features of the drawings will be coded using an emergent analytic technique that has been successfully applied to illuminate students' preference and comfort for writing with or without technology. The specific features coded in the drawings fall into four broad categories: Student Characteristics (what the students were doing), Technology Present (type of technology depicted), Student Demeanor (whether the student was depicted positively, negatively, or neutral), and Other features (presence of teacher or other students, classroom decorations, multi-frame drawing). Aggregate grade level and school level student drawing data will be analyzed for each year of student 1:1 computing.

Teacher Interview

Although all participating teachers will be surveyed on multiple occasions over the course of the three year evaluation, both informal and structured formal teacher interviews will also be performed to gain a richer and more in-depth understanding of how 1:1 computing has impacted teachers and students motivation and engagement as well as general teaching and learning. The teachers will be given an opportunity to reflect on the program though the interview process and provide more vivid and anecdotal evidence to compliment the quantitative evaluation data. In addition, participating teachers will be interviewed both formally and informally about the variety of ways in which they use laptops in and out of schools. The interviews are scheduled along the student deployment of 1:1 laptops over the course of the three-year evaluation to allow the interviewer to query and clarify initial evaluation findings and assumptions.

The interviews will be conducted by a trained researcher and will be expected to range between 20 to 40 minutes depending on context and subject matter. All teacher interviews will share a basic core of questions that has emerged from the survey data and observations, however, the interview will remain open-ended enough to allow respondents to discuss a wide variety of issues. Notes and recordings from the interview will be analyzed using qualitative research software so that trends and patterns can be illuminated, however, the individual voice of the teacher respondents will, in and of itself, serve to inform the evaluation.

Qualitative Classroom Observations

A notable absence in the literature and discussions of 1:1 computing are actual examples of ways teachers and students actively use the technology-enriched environment to approach the curriculum. In the current study, the primary purpose of the classroom observations is to develop a deeper understanding of the ways in which the 1:1 laptops are being used throughout the school day so that we can provide a richer description of these uses in the evaluation reports.

As we have done in past research, we will employ a computer-based FileMaker database note taking tool that allows researchers to capture and categorize observation notes while in the field and which decreases time to code and analyze qualitative data. In addition to traditional qualitative note taking the software features a prompt to the observer to record a variety of technology and curricular information at fixed ten-minute intervals including:

the number of computers in use by students,
the location and role of the teacher, and
the configuration of the students (working alone, in small groups, whole class, etc.).

At the present time the Boston College evaluation team is in the process of developing a collaborative relationship with the Massachusetts College of Liberal Arts (MCLA) to use advanced undergraduate psychology and education MCLA students to collect the classroom data. It is currently expected that student training (including reliability trials) will be led by the BC evaluation team in Fall 2005 and that student observers will be in 7th grade 1:1 classrooms documenting practices by Spring 2006. Given the role of the classroom observations in the current study, all classroom observations will be conducted only in 1:1 classrooms. Additionally, classroom observations are only going to be initially scheduled at the Conte Middle School in North Adams given its close geographic proximity to the MCLA campus. The role and utility of the classroom observations will be periodically reconsidered throughout the three-year evaluation and may be adapted to better suit the aims and goals of the project.

Achievement Study

In the current study we are proposing the most thorough examination of the impacts of 1:1 computing on student achievement to date. As such, perhaps the most anticipated results from the BWLI evaluation will be the examination of the impact of the 1:1 technology on student achievement as measured by state's annual Massachusetts Comprehensive Assessment System (MCAS) as well as by an inTASC created assessment.

Given our reliance upon the state test, we are working around the state's projected assessment schedule and parameters. Currently, MCAS testing is conducted annually in April with assessments for students across grade 6, 7, and 8. Table 1, below, shows the testing areas by grade level across the three years of the BWLI evaluation.

Table 1: MCAS Testing Schedule by Grade Level

	Year 1 (4/06)			Year 2 (4/07)			Year 3 (4/08)		
ELA Language and Lit.	6	7	8	6	7	8	6	7	8
Math	6		8	6		8	6		8
ELA Comprehension		7			7			7	
Science/Technology			8			8			8

Source: http://www.doe.mass.edu/mcas/cal.html Accessed: August 15, 2005

From the above schedule we will coordinate our data collection efforts. Specifically, we aim to collect student level and item level MCAS data each year for all participating BWLI students as well as from students in the four comparison group settings. Note that one of the four participating schools in the pilot program (St. Mark) does not have students take the MCAS, leaving the remaining three public schools eligible for MCAS analysis. Another evaluation challenge is the length of time required to receive student level test scores through each participating school after April testing (typically five months).

Using the state supplied student data files available in late summer, the evaluation team will link student and teacher survey data to the student achievement data across the three public BWLI schools and four comparison sites. As we have done in previous research (O'Dwyer, Russell, Bebell and Seeley; 2004), students' MCAS raw scores and subscale scores would be used as the dependent variables in regression analyses that use a variety of surveyed specific technology use scales as independent variables. It is also important to again note that previous measures of student achievement, namely prior MCAS achievement, will be used as a covariate to differentiate the effects of technology use from prior student ability. This combination of research design characteristics will yield data that explores what specific types of student technology use is related to specific types of achievement gains rather than broadly estimating how much a students score will change when given a laptop.

Given the limitations of the MCAS timeline and the importance of demonstrating the impacts of the pilot technology program on student achievement, we will devise and administer a computer based writing assessment that would be given in Spring to all 1:1 students across the four pilot schools (n=2266+/-) and a sample of students from the four non-1:1 comparison sites. The writing assessment will consist of a previously released MCAS or National Assessment of Educational Progress (NAEP) item and could be taken by the students with or without technology (their choice). Students' performance on the writing assessment would serve as a dependent variable in a regression analysis where various student technology uses would serve as independent variables along with traditional demographic items. Such an analysis would yield data that would directly address how participation in the technology pilot program, as well as which specific student technology practices yield to quantifiable differences in a controlled measure of student achievement.

In summary, results from the MCAS and the inTASC writing assessment with the individual teacher and student survey results will allow for the empirical investigation of specific technology uses across different areas of student achievement. In other words, using the student and teacher demographic items can address which types of students seem to get the greatest academic benefits

from specific technology uses. Additionally, any differential effects associated with students' computing skills could be examined using the technology fluency and technology literacy data. Given the variety of student achievement outcome variables, the effects of technology can be addressed through a series of OLS multiple regression analyses with different dependent variables (O'Dwyer, Russell, Bebell and Seeley; 2004; Pearson, Pilcher, & Weeks, 1996). Each regression model will include predictor variables such as student SES and gender in addition to the various in-school and at-home technology measures. Such models allow for the direct comparison of the predictive strength of the technology uses to more commonly used predictor variables across a number of different student achievement outcome measures.

Analysis of School Records

At the end of each school year, the evaluation team will work with school officials to collect and analyze various data sources from each of the four participating schools as well as in corresponding grade levels at the four comparison sites. Data sources including attendance, tardiness and disciplinary referrals will be collected to assess the impacts of the wireless laptop initiative through comparisons to past historic levels for an aggregate class across the four BWLI sites and compared to changes observed in the non-1:1 comparison schools.

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