



MARCH 2009

# Berkshire Wireless Learning Initiative Final Evaluation Report

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## Analyses of Student Achievement

The current investigation employs MCAS results to demonstrate the impacts of the BWLI program and the subsequent experiences of 1:1 computing on students and schools. In the following exploration of student achievement, we will consider results from a variety of approaches including both school averages and individual student results for those 7th and 8th grade students who attended BWLI schools and experienced two years of 1:1 student computing. Specifically, the current investigation will address:

- achievement trends in schools overall MCAS performance over time compared to the comparison schools and state trends, and
- which, if any, of students technology uses in school or home have impacted student-level performance on various MCAS outcomes (while statistically controlling for students pre-BWLI academic performance using prior MCAS performance)

### School-level Trend Analyses

As previously described in the methodology section, school-level MCAS results and performance indicators from 1998 to 2008 were accessed from the Massachusetts Department of Education. Given the non-experimental research design (i.e. students were not randomly assigned to 1:1 laptop or comparison settings), it is impossible to attribute changes in academic performance directly to participation in the BWLI program. Furthermore, since each of the participating schools were also engaged in other school reform practices and initiatives aimed at improving student achievement, the specific role of the BWLI program and technology practices in schools can not be fully isolated. However, both the school trends and student-level analyses provide an empirical window onto emerging trends in student achievement across both laptop and comparison settings.

We begin our investigation of student achievement by exploring general trends observed across school level achievement data for 7th and 8th grade students both before and during the BWLI implementation period. To appeal directly to school-level policy makers, we present the school-level MCAS results using the percent of students at each school who “passed” the various subject examinations on the Grade 7 and 8 MCAS exam. After experimenting with a number of ways of presenting a schools performance on the MCAS, the percent of students passing was found to be easily interpretable and familiar to those experienced with this assessment. This passing rate was calculated using the performance categories assigned to all MCAS students by the state. Specifically, the total percentage of students who received scores in the “Warning/Failing” category were subtracted from the total number of students, resulting in the overall percent of student who “passed” the MCAS.

In the following tables, school performance is weighted and averaged across the three public BWLI schools and compared to the combined student performance in the two comparison settings as well as to statewide student performance. This summary of student achievement trends begins below, with Figure SA1 which shows the percent of “passing” students on the 7th grade ELA MCAS for BWLI schools, comparison schools, and the average state pass rates from 2001 to 2008.

**Figure SA1: Percent of students “passing” 7<sup>th</sup> grade ELA MCAS (2001–2008)**

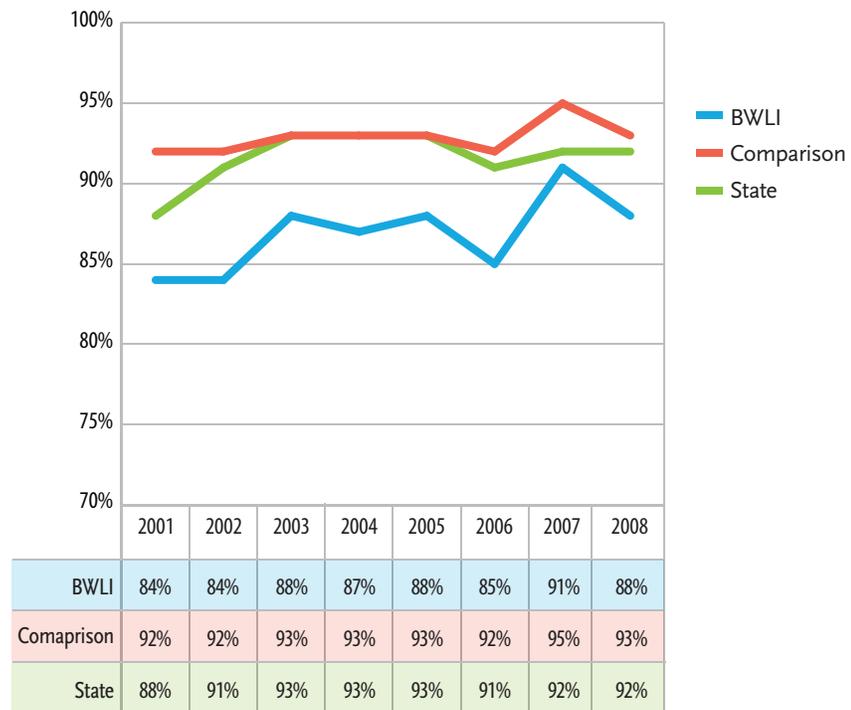


Figure SA1 shows the percent of 7th grade students who “passed” the ELA portion of the MCAS across the BWLI schools, the comparison schools, and the state average (n=72,799) going back to 2001<sup>2</sup>. Overall, it is apparent that students across all groups performed generally well on the 7th

grade ELA MCAS, with 84 to 95% of students typically receiving a “passing” score. In general, the pre-BWLI years (2001–2005) found the BWLI students lagging consistently about 5% below ELA pass rates in the comparison schools and the state averages. In the Spring 2006 7th grade MCAS administration, after the first months of transitioning to a 7th grade 1:1 learning environment, BWLI student performance on the ELA exam faltered somewhat (a 3% decrease in passing rates) compared to the non-1:1 schools in the comparison group and the state average. In trying to explain this data trend, we found that the Conte students did particularly poorly in 2006, when they experienced a 10% annual decrease in the percent of their students passing the ELA grade 7 examination.

However, in the first full year of 7th grade 1:1 computing, when student and teacher surveys suggest technology use had reached all time peaks, student performance on the 7th grade ELA MCAS saw its largest annual increase ever reported on the Spring 2007 assessment. This 6% percentage point improvement across the BWLI settings outpaced the change in both state averages and comparison school performance during this same time period, effectively eliminating the long-time gap between BWLI 7th grade ELA performance and the state averages. Moreover, the 2007 MCAS saw 91% of BWLI students “passing” which corresponded to the highest pass rates since the beginning of MCAS testing. However, the Spring 2008 MCAS administration saw a 3% drop in student performance in the BWLI schools whereas comparison schools dropped 2% and state averages were unchanged. The analyses of school-wide test data is continued below for the percent of 7th grade students who “passed” the Math MCAS across the BWLI schools, comparison schools, and the state average.

**Figure SA2: Percent of students “passing” 7<sup>th</sup> grade Math MCAS (2006–2008)**

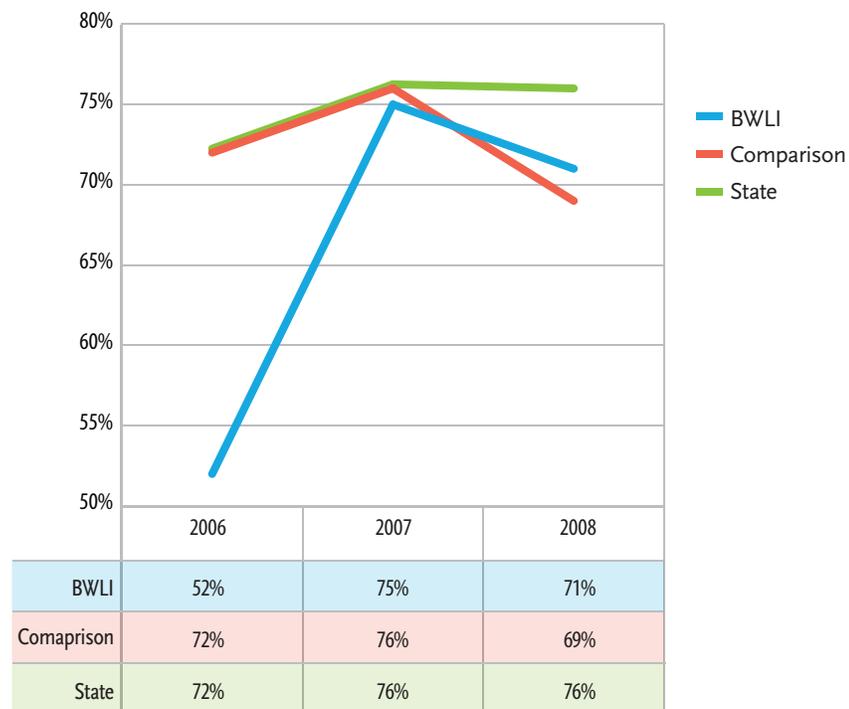


Figure SA2 shows the percent of 7th grade students who “passed” the Math portion of the MCAS across the BWLI settings, the comparison schools, and the state average since 2006, when the Math assessment was first introduced at Grade 7 by the state. In the Spring 2006 testing administration, which followed the first few months of 7th grade students transitioning to 1:1 computing, only about 52% of BWLI student “passed” the new 7th grade Math assessment, compared to 72% of students in the comparison settings and the state. Looking across the three BWLI schools (not presented in the figure), student pass rates at individual schools ranged from 49% to 55% in 2006. However across each of the BWLI schools, a substantial improvement in the number of students “passing” the 7th grade Math MCAS was observed for the Spring 2007 test administration bringing the average BWLI pass rate up to 75%. This somewhat unusual jump in student performance corresponded with the first full year of BWLI implementation at grade 7 and was observed in each tested BWLI setting. In addition, the 2007 Math MCAS administration found BWLI 7th graders within 1% of comparison school and state averages. In the 2008 assessment, corresponding to the final year of the BWLI program, 7th grade student performance fell somewhat across both BWLI schools and comparison settings with 71% and 69% pass rates, respectively.

Collectively, our examination of school performance on the 7th grade ELA and Math MCAS (Figures SA1 and SA2) found the highest percentages of students passing were observed in 2007, the first full year of the BWLI implementation in grade 7 and the year when students and teachers reported the most widespread and frequent use of technology in respective surveys. Grade 7 student performance in the BWLI settings reached its highest historical levels on both the ELA (since 2001) and Math (since 2006) MCAS during the year when BWLI implementation and use was at its peak. Without a true experimental design, this trend analyses does little to prove that the BWLI program improved test scores, however even a conservative assessment of the 7th grade MCAS pass rates over this time period suggests that the BWLI participation was conducive or complementary to practices that fostered improvements in test performance.

Our trend analyses of student achievement across BWLI, comparison schools, and the state average is continued below with 8th grade class performance in ELA, Math, and Science. Specifically, Figure SA3 illustrates the percent of BWLI and comparison students who received a “passing” score on the 8th grade ELA.

**Figure SA3: Percent of students “passing” 8<sup>th</sup> grade ELA MCAS (1998–2001; 2006–2008)**

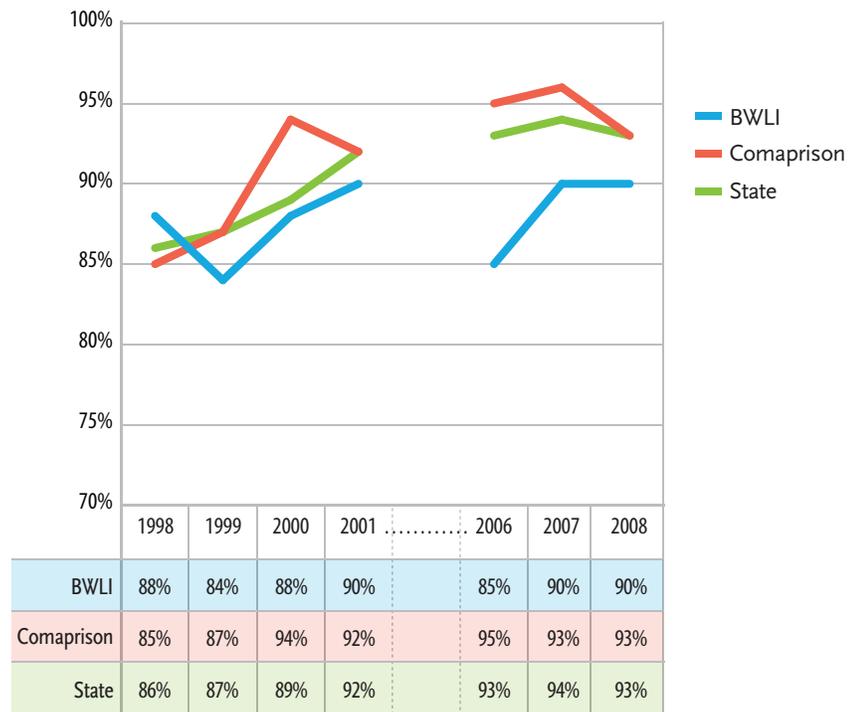


Figure SA3 illustrates the percent of 8th grade students who “passed” the ELA portion of the MCAS across the BWLI settings, the comparison schools, and the state average from 1998 to 2001 and again from 2006 and 2008<sup>3</sup>. In the three years of school performance data collected prior to 2006, average ELA performance generally increased across all settings, although BWLI schools generally witnessed less growth than either state or comparison schools. However, the overall pass rate in each examined setting was 90% or better. When the ELA 8th grade assessment was resumed in 2006, 85% of students in the BWLI setting received “passing” scores compared to 95% percent of students in the comparison setting and 93% of the state’s 73,268 students who completed the assessment. In 2006, the 8th grade BWLI students had not participated in the BWLI program. By the Spring 2007 assessment, 8th grade students across the BWLI settings had 1:1 laptop access throughout their 8th grade year as well as during the last half of 7th grade. In 2007 the BWLI schools performed considerably better than the 2006 cohort had, with a 5% increase in the percent of students passing bringing the total back up to 90%. Student performance across the BWLI schools remained consistent at 90% for the 2008 assessment. However, despite these post-1:1 laptop increases, the

percent of BWLI students passing the ELA 8th grade MCAS remained slightly less than in comparison schools or the state average where scores experienced small fluctuations, but did not realize the improvements witnessed across each of the BWLI schools. Further comparisons of the pass rates in BWLI schools and other settings are continued below in Figure SA4 which shows average results from 1998 to 2008 on the 8th grade Math MCAS.

**Figure SA4: Percent of students “passing” 8<sup>th</sup> grade Math MCAS (1998–2008)**

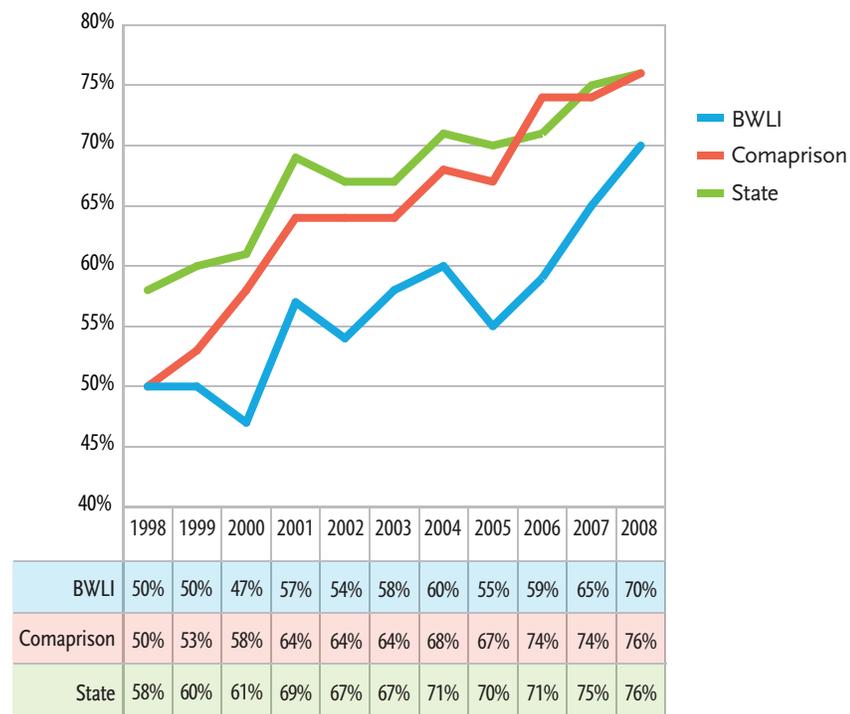


Figure SA4 shows the percent of BWLI students, comparison students, and the state average who passed the 8th grade Math MCAS each year from 1998 to 2008. With the first MCAS assessment in 1998 both BWLI and comparison setting pass rates were 50% on average, 8% below the state average of 58%. Over the next seven years (the pre-BWLI period), scores in the comparison setting rose steadily eliminating their performance gap with the state average. In this same time, BWLI scores also increased although less dramatically so that by the 2005 and 2006 assessments, BWLI pass rates were increasingly lagging behind both comparison schools and state averages. In 2006, the overall pass rate for the 8th grade Math MCAS was 59% in the BWLI settings compared to 74% in the comparison schools and 71% statewide.

The Spring 2007 MCAS assessment represents the first time the 8th grade student cohort had 1:1 laptop access including most of their 8th grade year as well the last half of their 7th grade year across the BWLI schools. Like we have seen in other subject areas and grade levels, this cohort of BWLI students showed strong progress in improving pass rates 5% during each year of the 8th grade BWLI implementation, bringing the average pass rate up to 70% by 2008. In other words,

this unprecedented two-year improvement in 8th grade Math pass rates across BWLI settings corresponded with students participation in the 1:1 laptop program, and served to narrow the long term gap in test performance with both the comparison schools and the state averages. The analyses of the school-level trends in MCAS performance is completed below, in Figure SA5, with an examination of the percent of students “passing” the 8th grade Science MCAS.

**Figure SA5: Percent of students “passing” 8<sup>th</sup> grade Science MCAS**

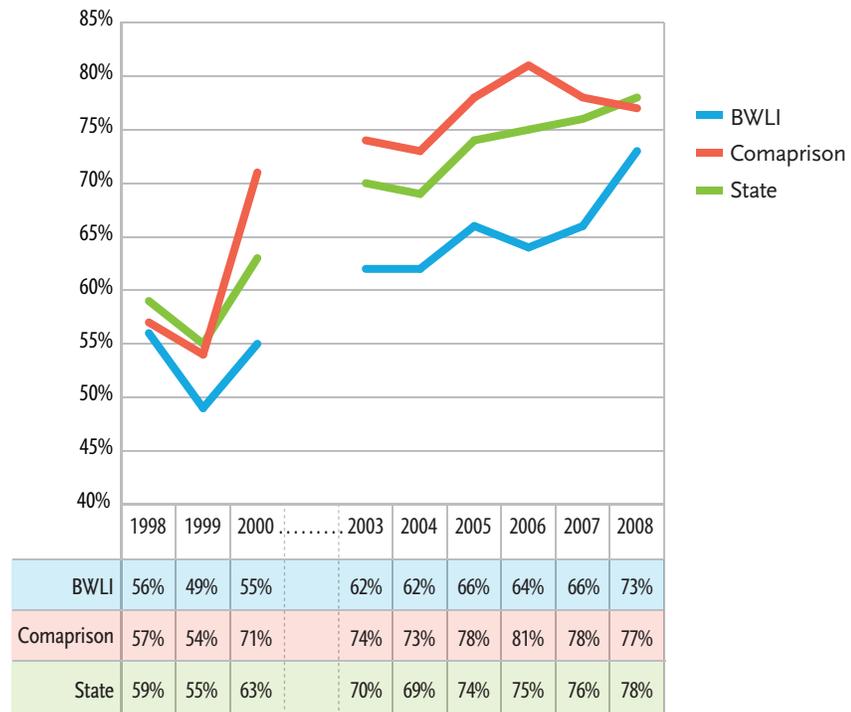


Figure SA5 illustrates the percent of 8th grade students who “passed” the science portion of the MCAS across the BWLI settings, the comparison schools, and the state average from 1998 to 2000 and again from 2005 and 2008. In the three years of school performance data collected prior to 2005, average science performance first decreased and then rebounded across all settings, although BWLI schools generally witnessed less growth than either state or comparison schools. In 2000, the BWLI 8th grade science pass rate was 55% compared to 63% statewide and 71% in the comparison schools. When the 8th grade science assessment was resumed in 2003, 62% of students in the BWLI setting received “passing” scores compared to 74% percent of students in the comparison setting and 70% of the states 73,203 students. In all settings, pass rates were generally stable or improved from 2003 to 2006 although BWLI average scores dropped slightly in 2006, the last available year of data before the 1:1 laptop cohort was tested in 2007. In the Spring 2007 and 2008 assessments, corresponding with the 1:1 deployment in the BWLI settings, BWLI pass rates rose to their highest recorded levels with 73% of 8th graders “passing” the Science MCAS in 2008. The large improvements in the BWLI setting served to close the historic gap in Science pass rates that was

observed with the state and comparison school averages, since the state and comparison data rose less dramatically during this period.

Collectively, this examination of test results for 8th grade performance on the ELA, Math and Science MCAS (Figures SA3 through SA5) found the highest levels of student achievement were observed in 2007 and/or 2008, the two years that the BWLI implementation provided 1:1 laptops to grade 8 students. Like the patterns observed for the 7th grade assessments, grade 8 student performance in the BWLI settings reached its highest historical levels in every tested subject area (ELA, Math, and Science) when the BWLI implementation and use were at their peak. Again, without a true experimental design, this trend analyses does little to *prove* that the BWLI program improved test scores, however the trends presented for the 8th grade MCAS over time suggest that the BWLI participation was certainly conducive or complementary to practices that raised pass rates of students in BWLI schools. Given that each year of our MCAS analyses represents different cohorts of students, there is a possibility that the improvements realized during the BWLI years may also be attributed (in full or part) to pre-existing characteristics of the student body who completed the exam in 2007 and 2008. Although it seems fairly unlikely that the years of the full 1:1 laptop implementation also witnessed better performing students in each of the BWLI schools than had existed historically, without a randomized experimental study it is impossible to completely attribute these test score gains to the BWLI program. However, it is possible to examine the potential of any “cohort effect” within these results through further examination of how individual students performance on the MCAS has changed during the BWLI implementation period. In other words, how much improvement, if any, was observed for 8th grade students test performance after two years of 1:1 computing compared to the same students two years earlier in grade 6. Table SA1 summarizes such an analyses for BWLI and comparison student performance levels on the ELA and Math MCAS.

**Table SA1: Percent change in MCAS performance levels from 2006 6<sup>th</sup> grade administration to 2008 8<sup>th</sup> grade**

|                           | ELA        |                 |           | Math       |                 |            |
|---------------------------|------------|-----------------|-----------|------------|-----------------|------------|
|                           | Improved   | Stayed the Same | Decreased | Improved   | Stayed the Same | Decreased  |
| Conte Middle School       | 25%        | 71%             | 4%        | 33%        | 62%             | 5%         |
| Herberg Middle School     | 36%        | 55%             | 9%        | 18%        | 67%             | 15%        |
| Reid Middle School        | 32%        | 57%             | 11%       | 19%        | 62%             | 19%        |
| North                     | 21%        | 72%             | 6%        | 26%        | 68%             | 6%         |
| South                     | 20%        | 68%             | 12%       | 14%        | 67%             | 18%        |
| <b>BWLI Schools</b>       | <b>32%</b> | <b>59%</b>      | <b>9%</b> | <b>21%</b> | <b>64%</b>      | <b>15%</b> |
| <b>Comparison Schools</b> | <b>21%</b> | <b>70%</b>      | <b>9%</b> | <b>21%</b> | <b>68%</b>      | <b>11%</b> |

Table SA1 shows the percent of BWLI and comparison students who improved, decreased, or stayed the same in their MCAS performance category from the 6th grade 2006 MCAS assessment to the 8th grade assessment in 2008 for these same students. In other words, these results summarize the percent of individual students who changed their MCAS performance category during their 7th and 8th grade years when 1:1 computing was available across the BWLI settings. For the ELA results, each of the BWLI schools witnessed between 25% (Conte) to 36% (Herberg) of their students improving one or more performance categories on the 8th grade MCAS compared to students previous 6th grade performance. Collectively, the weighted ELA average across all of the BWLI students resulted in improvements for 32% of students compared to only 21% in the comparison settings. In both 1:1 and comparison settings, there were 9% of students observed decreasing one or more performance categories over the two years corresponding with BWLI implementation. Math results during this same time period found more varied results across the BWLI schools than had been observed in ELA. Specifically, the Conte students saw the largest increase in their Math performance categories with 33% of 8th graders improving their grade 6 performance. However, results from the Herberg and Reid schools found only 18% and 19% of their respective students improved one or more performance categories on the 2008 Math MCAS, which was less than the average improvement rate across the two comparison schools. Thus, the total average of improvement in BWLI settings in Math was equivalent to the improvement in performance observed on average in the comparison schools (21%). In addition, the average of BWLI students decreasing their performance in Math MCAS (15%) was greater than the average for comparison students (11%), although Conte observed the smallest percentage of their students decreasing in math performance (5%).

These ELA and Math results suggest that the 1:1 computing model ushered in by the BWLI program had somewhat different levels of impact across the BWLI schools. However, even when results are examined across all of the BWLI settings, more students improved their ELA and Math performance during the BWLI implementation years than had declined. Across subject areas, improvements were greatest for the ELA exam where BWLI students improved their performance levels with greater frequency than students in the comparison settings. Results in Math were also quite positive at the Conte school during the 1:1 implementation, but results in the other two 1:1 schools (Herberg and Reid) more closely resembled student performance in the comparison settings. Combined with the historical trend data presented in Figures SA1 through SA5, these results suggest that the cohort of BWLI students who performed historically well on the 2007 and 2008 MCAS likely represent school-based efforts to raise student scores such as 1:1 computing, as evidenced by the impressive percent of individual students who improved their MCAS ELA performance level as they progressed through the two full years of the BWLI implementation. In other words, the positive test results observed in BWLI schools during the 1:1 implementation period are likely not simply a result of one or two classes of students who simply tested better than past cohorts for some unknown reason, given that when we followed a single cohort of students through the BWLI years we witnessed between 18% to 36% of students improving their MCAS performance these two years, particularly in ELA.

### ***Student Level Relationship Between Achievement and Technology Use***

To further explore the relationship between student achievement and participation in 1:1 computing activities, an analysis of individual student-level data was examined within the context of actual student technology practices during the third and final year of the BWLI implementation (2007-2008). (An exploratory analysis of student achievement and Year 2 student practices was presented in the BWLI Year 2 Annual Report (Bebell, 2008)). As previously described in the methodology section, a new data set was created that included the state's MCAS results and demographic information as well as the BWLI student survey for each and every student in the BWLI and comparison group settings. Thus, for each 7th and 8th grade student who completed the MCAS and the BWLI survey, the relationship between various technology uses and various outcome/student achievement measures could be examined.

Table SA2 provides demographic information from the newly merged 2007–2008 MCAS/BWLI data set across the 7th grade BWLI and comparison school settings.

**Table SA2: Grade 7 achievement and demographic data summary**

|   | <b>Conte</b> | <b>Herberg</b> | <b>Reid</b> | <b>North</b> | <b>South</b> |
|---|--------------|----------------|-------------|--------------|--------------|
| % of Students eligible for free/reduced lunch | 54%          | 41%            | 53%         | 19%          | 44%          |
| % of non-white (A, B, H, M, N) students       | 17%          | 21%            | 22%         | 8%           | 16%          |
| Mean ELA raw score                            | 47.9         | 48.7           | 47.7        | 51.2         | 49.5         |
| Mean Math raw score                           | 29.0         | 35.2           | 31.6        | 31.3         | 31.7         |
| # of Students who completed 2008 MCAS         | 110          | 223            | 235         | 281          | 226          |
| # of Students who completed 2008 BWLI survey  | 106          | 210            | 213         | 141          | 175          |
| # of Special education students               | 25           | 35             | 50          | 58           | 51           |

In addition to showing the mean MCAS scores across the each school's 7th grade class, the state data shows the percent of students who were eligible to receive free or reduced lunch (a common indicator of students' socioeconomic status), the percent of non-white students (an indicator for ethnic/racial diversity), the number of special education students, as well as the number of students who completed the final Year 3 BWLI survey (June 2008). Looking across the 7th grade settings, MCAS scores were similar although there was greater variance for the data summarizing the number of students who received free/reduced lunch or were classified by the state as non-white. Across each school, a number of students were reported to receive Special Education services. Lastly, Table SA2 shows that the overwhelming majority of 7th grade BWLI students completed the June 2008 BWLI survey while a slightly smaller percentage of comparison school students completed the survey. Table SA3 shows a similar table describing various achievement and demographic summary statistics for grade 8 students.

**Table SA3: Grade 8 achievement and demographic data from the state**

|   | Conte | Herberg | Reid | North | South |
|---|-------|---------|------|-------|-------|
| % of Students eligible for free/reduced lunch | 44%   | 38%     | 57%  | 26%   | 45%   |
| % of non-white (A, B, H, M, N) students       | 16%   | 18%     | 24%  | 10%   | 20%   |
| Mean ELA raw score                            | 34.6  | 35.6    | 34.8 | 36.7  | 34.5  |
| Mean Math raw score                           | 31.4  | 31.9    | 29.7 | 33.7  | 30.5  |
| # of Students who completed 2008 MCAS         | 116   | 268     | 219  | 237   | 238   |
| # of Students who completed 2008 BWLI survey  | 115   | 253     | 211  | 172   | 177   |
| # of Special education students               | 21    | 43      | 34   | 42    | 43    |

Table SA3 shows a summary of demographic and student achievement data across the grade eight BWLI and comparison school students who completed the MCAS in Spring 2008. In addition to showing the mean MCAS scores across the each school's 8th grade class, the state data shows the percent of students who were eligible to receive free or reduced lunch, the percent of non-white students, the number of special education students, as well as the number of students who completed the final Year 3 BWLI survey (June 2008). Looking again across the schools, MCAS scores were fairly similar although there was greater variation in the data concerning the number of students who received free/reduced lunch or were classified by the state as non-white.

Exploratory data analyses were performed using the student data to investigate if the frequencies of teachers' and students' various technology uses (as measured by the BWLI student survey) exhibited any notable relationship with the 2008 student achievement results. More simply, did any of students' specific uses of technology during the third year of the BWLI program relate to their test performance? For example, did the students who reported more frequent use of technology for presenting information in class perform any better on the MCAS math section than students who rarely used technology for this purpose? Given the fact that there was such wide variation in many of the computer use measures across and between the BWLI and comparison school students, the current sample provides a rich data set for such preliminary explorations.

Because there were such a wide ranging number of surveyed student technology uses, the common statistical approach of factor analyses was applied across the student survey items to create more reliable and stable measures of student practices within the 1:1 and comparison school settings. Specifically, principal component analysis was applied to create six scales representing different types of technology use in school for: writing and research, solving problems, presenting information, class-related activities, communicating, and teacher use of computers. Four additional scales were created from the student survey results to represent students varied home use of computers including: writing and research, multimedia, communication and social use, and recreational use. Lastly, student attitudes and beliefs were summarized across survey items to form two scales concerning students' beliefs towards the 1:1 computing and students self-perception of their technology abilities. All of the student technology use and attitude scales used in across the current study of student

achievement are fully detailed in Appendix A: Construction and statistical qualities of the BWLI student survey measurement scales.

Through an analysis of student test performance and various indicators of technology practices, it is possible to get some general understanding of the complex relationship between student and teacher practices during the 2007–2008 school year and measures of student achievement. Through this type of analysis (including students from non-1:1 laptop settings in comparison groups) it can also be shown if specific technology practices appear to be impacting test scores positively, negatively, or not at all

In the following analyses, the relationship between BWLI teachers' and students' use of technology and MCAS performance is demonstrated using Pearson's correlation coefficients ( $r$ ). For those readers unfamiliar with examining relationships between variables using correlation, accepted guidelines for interpreting the  $r$  values are reproduced in Table SA4 from Guilford's (1954) *Psychometric Methods*.

**Table SA4: Interpretation of correlation coefficient**

| $r$ Value     | Interpretation                                      |
|---------------|---|
| Less than .20 | Slight; almost negligible relationship              |
| .20 – .40     | Low correlation; definite but small relationship    |
| .40 – .70     | Moderate correlation; substantial relationship      |
| .70 – .90     | High correlation; marked relationship               |
| .90 – 1.00    | Very high correlation; very dependable relationship |

In the following example a positive correlation indicates that increased use of technology was associated with higher 2008 MCAS scores. A negative relationship would indicate that as students' use of technology increased, their test performance decreased. A common method for evaluating the strength of a correlation is to test the value for statistical significance. Significance testing provides an indication of the strength of the relationship and whether the relationship can be attributed to chance. For the correlation tables of student results presented in the current paper, correlation values found to be statistically significant are depicted in bold ( $p < .05$ , 2-tailed test). Again, these correlation results are not intended to determine the effectiveness of the BWLI program or its various components, but rather to explore what student and teacher uses may be related to a common measure of student achievement. In the tables below, the correlation between Year 3 technology uses and Spring 2008 MCAS scores are presented below for 7th and 8th grade students. Specifically, Table SA5 shows the correlation table between 7th grade students' commonly reported technology uses, demographic variables, and students' grade 6 (2007) ELA and Math MCAS performance.

**Table SA5: Correlation table between 7<sup>th</sup> grade students commonly reported technology uses, demographic variables, and 2008 MCAS performance**

|   | BWLI        |             | Comparison  |             |
|---|-------------|-------------|-------------|-------------|
|   | ELA         | Math        | ELA         | Math        |
| ELA raw score   |             | <b>.68</b>  |             | <b>.68</b>  |
| Math raw score  | <b>.68</b>  |             | <b>.68</b>  |             |
| ELA raw score 2007 (6th grade)  | <b>.78</b>  | <b>.70</b>  | <b>.78</b>  | <b>.68</b>  |
| Math raw score 2007 (6th grade)                                       | <b>.67</b>  | <b>.86</b>  | <b>.68</b>  | <b>.87</b>  |
| Socio-economic status   | <b>.34</b>  | <b>.38</b>  | <b>.40</b>  | <b>.37</b>  |
| <b>Student use in school</b>  |             |             |             |             |
| In the past year, how often did you use technology in your classroom? | <b>.08</b>  | <b>.16</b>  | <b>-.40</b> | <b>-.19</b> |
| Student computer use in Reading/ELA                                   | .02         | <b>.12</b>  | <b>-.36</b> | <b>-.23</b> |
| Student computer use in Social Studies                                | -.02        | -.04        | <b>-.20</b> | <b>-.15</b> |
| Student computer use in Math  | -.06        | .02         | <b>-.29</b> | <b>-.20</b> |
| Student computer use in Science                                       | .02         | <b>.15</b>  | <b>-.27</b> | <b>-.18</b> |
| Writing and research  | .05         | <b>.10</b>  | <b>-.24</b> | <b>-.17</b> |
| Solve problems  | -.04        | -.01        | -.07        | -.04        |
| Present information   | <b>-.08</b> | <b>-.05</b> | -.11        | -.05        |
| Class-related activities  | -.08        | -.09        | <b>-.17</b> | -.08        |
| Teacher use of computers  | .04         | <b>.09</b>  | -.02        | .01         |
| Communication   | -.04        | -.01        | -.07        | -.04        |
| <b>Uses at home</b>   |             |             |             |             |
| Writing and research  | -.06        | -.09        | .01         | -.04        |
| Multimedia use  | <b>.10</b>  | .01         | .02         | .05         |
| Communication   | .06         | .03         | .02         | .03         |
| Recreational home use   | <b>.10</b>  | .01         | .03         | .03         |
| Technology beliefs  | -.03        | -.01        | .07         | .04         |
| Self-perceived abilities  | .02         | .06         | -.03        | .01         |

Note: Bold correlations represent statistical significance at the .05 level (2 tail)

Table SA5 shows the correlational relationship between 7th grade students' 2008 performance on the ELA and Math sections of the MCAS with socioeconomic status indicators and commonly reported technology uses. Overall, it appears that there are a number of student level indicators (including students' and teachers' technology uses measured by the Spring 2008 survey) which were found to have a statistically significant relationship with student achievement as measured by the Spring 2008 MCAS. It is noteworthy that for both the comparison school sample and the BWLI sample, that the relationship between the ELA raw score and Math raw score exhibited a strong positive correlation (.68 in each setting) indicating that students' performance on the ELA section of the MCAS is strongly related with their performance on the Math sections. In addition, both samples of students exhibited very strong statistically significant relationships between their previous test performance and their 2008 MCAS performance, particularly in Math. Similarly, students' socio-economic status (SES), as measured by a scale incorporating a student's participation in free or reduced lunch programs and the number of books a student has at home as reported on the student survey, positively correlated with MCAS performance indicating that low-SES students received lower test scores than students with higher SES. All of these results suggest that students' background environment plays a substantial role in their subsequent 8th grade test performance. Clearly, the very large positive correlations observed when comparing students 2007 and 2008 test performance shows that students prior test performance is the strongest predictor of future performance, independent of setting, educational reforms, or practices.

In terms of the relationship between students' use of technology in the classroom and test performance, statistically significant (yet fairly weak) positive results were found for the BWLI 7th grade students (who had about two years of 1:1 use in school) while statistically significant negative results were found for the comparison school 7th grade students (who had never participated in a 1:1 laptop program). Specifically, BWLI students who reported using technology in the classroom during the 2007-2008 school year were found to score better on both the ELA and Math 7th grade assessment than those BWLI students who did not report as frequent use. This pattern was strongest for the Math assessment where the correlation between the raw score and frequency of in-class technology use was .16. In the comparison settings, the impact of technology use in the classroom was also correlated significantly with ELA and Math performance the relationship, however the relationship was negative and somewhat stronger. In other words, the students who reported the most frequent use of technology in the non-1:1 settings were the same students receiving lower MCAS scores, particularly in ELA where the observed Pearson correlation was  $-.40$ .

Also presented in Table SA5 is the relationship between the frequency of students' reported use of technology across their four primary classes (ELA/Reading, Math, Social Studies, and Science) and 2008 MCAS performance. The relationship between BWLI students' specific use and subsequent test performance was largely negligible or weak. BWLI students, however, exhibited statistically significant positive correlations between use in Reading/ELA and Science classes with their Math raw score on the 2008 MCAS, indicating greater technology use in these subjects was related to higher Math performance. Conversely, the relationship between student use of technology across the core curricular subjects and MCAS performance was entirely negative (as well as statistically

significant) for the comparison students, suggesting that these types of computer activities in non-1:1 settings was not positively related to increase student test performance.

Lastly, Table SA5 includes a summary of correlations between scales of specific student uses of technology in school and raw ELA and Math MCAS scores. As shown above, nearly all specific technology uses exhibited weak, negative correlations with test results both for BWLI students and comparison school students. These results suggest that the specific skills gained by students who frequently use these technology applications in school may be unrelated or negatively related with MCAS performance. Again, in this analysis we see BWLI students receiving more positive impacts from their use of technology than comparison students in the non-1:1 setting where nearly all specific school uses were negatively correlated with test performance. Specifically, for the BWLI 7th grade students, statistically significant positive correlations were observed for students' use of technology in-class for "writing and research", and "teachers use of computers" with their 2008 Math performance. A statistically significant negative correlation was observed for BWLI students' use of technology to present information in class with both ELA and Math sections of the MCAS. In addition, BWLI students frequency of home use of computers for "writing and research" as well as "recreational use" were observed to be positive statistically significant predictors for ELA raw scores, whereas no statistically significant predictors were observed across the non-1:1 settings. Neither students' technology beliefs or their self-perceived abilities to use technology were found to be statistically significant predictors of MCAS performance in BWLI or comparison settings.

Table SA6 continues the Year 2 analyses of student and teacher technology use during the 2007-2008 school year and 8th grade students' 2008 performance on the ELA, Science, and Math MCAS.

**Table SA6: Correlation table between 8<sup>th</sup> grade students commonly reported technology uses, demographic variables, and 2008 MCAS performance**

|   | BWLI        |             |             | Comparison  |             |             |
|---|-------------|-------------|-------------|-------------|-------------|-------------|
|   | ELA         | Math        | Science     | ELA         | Math        | Science     |
| ELA raw score   |             | <b>.71</b>  | <b>.76</b>  |             | <b>.69</b>  | <b>.72</b>  |
| Math raw score  | <b>.71</b>  |             | <b>.77</b>  | <b>.69</b>  |             | <b>.80</b>  |
| Science raw score   | <b>.76</b>  | <b>.77</b>  |             | <b>.72</b>  | <b>.80</b>  |             |
| ELA raw score 2007 (7th grade)  | <b>.77</b>  | <b>.63</b>  | <b>.65</b>  | <b>.80</b>  | <b>.66</b>  | <b>.65</b>  |
| Math raw score 2007 (7th grade)                                       | <b>.70</b>  | <b>.87</b>  | <b>.76</b>  | <b>.65</b>  | <b>.87</b>  | <b>.75</b>  |
| ELA raw score 2006 (6th grade)  | <b>.77</b>  | <b>.66</b>  | <b>.71</b>  | <b>.76</b>  | <b>.72</b>  | <b>.74</b>  |
| Math raw score 2006 (6th grade)                                       | <b>.66</b>  | <b>.83</b>  | <b>.71</b>  | <b>.61</b>  | <b>.87</b>  | <b>.73</b>  |
| Socio-economic status   | <b>.37</b>  | <b>.42</b>  | <b>.38</b>  | <b>.41</b>  | <b>.40</b>  | <b>.42</b>  |
| <b>Student use in school</b>  |             |             |             |             |             |             |
| In the past year, how often did you use technology in your classroom? | .04         | <b>.11</b>  | <b>.11</b>  | <b>-.18</b> | <b>-.11</b> | -.10        |
| Student computer use in Reading/ELA                                   | .08         | <b>.14</b>  | <b>.14</b>  | <b>-.11</b> | -.09        | <b>-.14</b> |
| Student computer use in Social Studies                                | <b>-.10</b> | -.04        | -.04        | .00         | -.05        | -.05        |
| Student computer use in Math  | .03         | <b>.10</b>  | <b>.10</b>  | -.06        | -.09        | -.07        |
| Student computer use in Science                                       | <b>-.15</b> | -.06        | -.06        | -.03        | -.01        | -.02        |
| Writing and research  | -.04        | .00         | .02         | <b>-.18</b> | -.08        | -.08        |
| Solve problems  | -.06        | -.07        | -.03        | -.04        | -.02        | .00         |
| Present information   | <b>-.10</b> | <b>-.10</b> | -.07        | -.05        | .00         | .03         |
| Class-related activities  | -.08        | -.06        | <b>-.09</b> | <b>-.16</b> | -.10        | -.05        |
| Teacher use of computers  | .06         | <b>.09</b>  | <b>.09</b>  | .05         | .06         | .03         |
| Communication   | .05         | .04         | .04         | .01         | .06         | .06         |
| <b>Uses at home</b>   |             |             |             |             |             |             |
| Writing and research  | .01         | -.02        | -.02        | -.07        | -.02        | -.03        |
| Multimedia use  | .09         | .09         | .06         | -.06        | <b>-.12</b> | -.06        |
| Communication   | .06         | .07         | .03         | -.05        | -.04        | .02         |
| Recreational home use   | <b>.09</b>  | <b>.09</b>  | .07         | -.05        | -.09        | -.05        |
| Technology beliefs  | .01         | .05         | .01         | -.01        | .08         | .00         |
| Self-perceived abilities  | <b>.12</b>  | <b>.12</b>  | <b>.09</b>  | -.04        | -.01        | .01         |

Note: Bold correlations represent statistical significance at the .05 level (2 tail)

Table SA6 shows the correlational relationship between 8th grade students' 2008 performance on the ELA, Math, and Science sections of the MCAS with socioeconomic status indicators and commonly reported technology uses. Overall, it appears that there are a number of student level indicators (including students' and teachers' technology uses measured by the Spring 2008 survey) which were found to have a statistically significant relationship with student achievement as measured by the Spring 2008 MCAS. It is again noteworthy that for both the comparison school sample and the BWLI sample, that the relationship amongst the 2008 tested subjects (ELA, Math, and Science) exhibited strong positive correlations (between .69 and .80) indicating that students' performance on one section of the MCAS was likely to highly indicative of their performance in other tested subject areas. In addition, there was a very strong statistically significant relationship between students 2008 8th grade MCAS performance and their prior performance on MCAS, particularly in Math where correlations were observed as high .87. Similarly, students' socio-economic status (SES), as measured by a scale incorporating a student's participation in free or reduced lunch programs and the number of books a student has at home as reported on the student survey, was positively correlated with MCAS performance indicating that low-SES students received lower test scores than students who were not eligible for assistance programs. As noted in the 7th grade results, again all of these results in the 8th grade suggest that students' background environment plays a substantial role in their subsequent test performance. In addition, the relationship between past achievement and student home variables on test performance has a long history in educational research and testing, and the results presented here echo much of this literature. Clearly, the very large positive correlations observed across students 2007 and 2008 test performance show that students prior test performance is the major predictor of future performance, independent of setting, educational reforms, or practices.

In terms of the relationship between students' use of technology in the classroom and test performance, statistically significant (yet fairly weak) positive results were found for the BWLI 8th grade students (who had about two years of 1:1 laptop use in school) while statistically significant negative results were found for the comparison school 7th grade students (who never participated in a 1:1 laptop program). Specifically, BWLI students who reported using technology in their classroom during the 2007–2008 school year more frequently were found to score better on both the Math and Science 8th grade assessment than those BWLI students who did not report as frequent use. In the comparison settings, the impact of technology use in the classroom was also correlated significantly with ELA and Math performance, however the relationship was negative.

Also presented in Table SA6 is the relationship between the frequency of students' reported use of technology across their four primary classes (ELA/Reading, Math, Social Studies, and Science) and 2008 MCAS performance. The relationship between BWLI test performance and students subject specific technology use varied by subject area, however statistically significant relationships were observed for ELA, Math, and Science. Student use of computers in Social Studies and Science classes was negatively correlated with MCAS ELA scores across BWLI students. Conversely, student use of computers in Reading/ELA and Math classes was positively correlated with Math and Science MCAS performance in the BWLI settings. For the comparison students, the relationship between student use of technology across the core curricular subjects and MCAS performance was again

entirely negative. Statistically significant correlations were observed for students use of computers in Reading/ELA and student performance in ELA and Science, suggesting that the types of computer activities in non-1:1 settings were not necessarily conducive to increased student test performance.

Lastly, Table SA6 includes a summary of correlations between scales of specific student uses of technology in school and ELA, Math, and Science MCAS scores. As shown above, nearly all of the specific technology uses exhibited weak, negative correlations with test results both for BWLI students and comparison school students. These results suggest that the specific skills gained by students who frequently use these technology applications in school may be unrelated or even negatively related with MCAS performance. Again, in this analyses we see BWLI students witnessing somewhat more positive impacts from their use of technology than comparison students in the non-1:1 setting where nearly all specific school uses were negatively correlated with test performance. Specifically, for the BWLI 8th grade students, statistically significant positive correlations were observed for students' in school use of technology for "communication" with their 2008 Math and Science performance. Two statistically significant negative correlations were additionally observed; for BWLI students' use of technology in school to "present information in class" with ELA and Math performance and "in class activities" with Science. In addition, BWLI 8th grade students frequency of home use of computers for "recreational use" was observed to be a positive statistically significant predictors for ELA and Math raw scores, whereas multimedia use was a negative statistically significant predictor in the non-1:1 settings. Lastly, students' technology beliefs towards the 1:1 program were not found to be statistically significant predictor of MCAS performance in BWLI or comparison settings, however in the BWLI setting students perceived abilities to use technology exhibited a statistically significant correlation with students MCAS performance across all tested subjects.

### ***Determining the Relationship Between Student Level Technology Use and Student Achievement***

In the preceding tables and statistics, the relationship between students' use of technology and measures of student achievement is explored for BWLI and comparison school students. Through these exploratory analyses on potential variables that may impact students' achievement, previous achievement on prior MCAS exams was clearly the largest and most substantial predictor of students' performance on the 2008 assessments. In addition, students' socio-economic status was also a consistently strong predictor of all student achievement measures. Of more interest to the current inquiry, a number of student technology use indicators were also found to be statistically significant predictors of different student achievement measures. However, given that prior MCAS performance is such a strong predictor of current and future achievement, does participation in the BWLI program, or in any of students' specific technology uses still have an impact of student achievement after the large effects of prior achievement are statistically controlled? In other words, did being in the BWLI program and using technology in school results in student test performance beyond what we would expect for students given their past performance? The following analyses of 8th grade 2008 BWLI and comparison student participants seek to address this question.

All 8th grade BWLI students completed the ELA and Math MCAS in Spring 2008 after nearly two full years of participation in 1 to 1 learning environments. The Spring 2006 MCAS assessment (completed by these same students when they were in grade 6) represents the last available state assessment results before students were exposed to the 1:1 setting, and given that both ELA and Math subject exams were offered, is an excellent subject-specific measure of pre-laptop student achievement. By combining 2006 and 2008 MCAS results along with the 2008 student survey results for each student it is possible to ascertain specifically how much scores for individual students rose or fell during this time period. Table SA7, below, shows average 2006 and 2008 MCAS raw scores for BWLI and comparison students:

**Table SA7: Mean 2008 ELA and Math raw scores for 8<sup>th</sup> grade BWLI and comparison students compared to their 2006 MCAS raw scores**

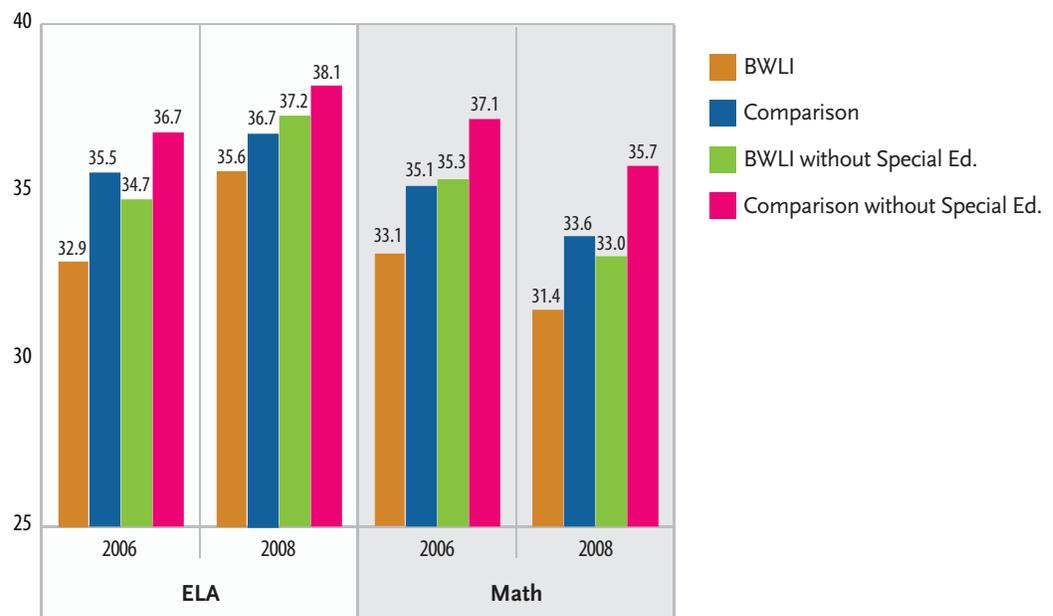


Table SA7 illustrates the mean ELA and Math MCAS performance for 8th grade students in 2008, compared to the same students performance on the grade 6 ELA and Math MCAS in 2006. The figure shows the averages for BWLI students, who had approximately two years experience in a 1:1 environment, as well as for comparison students from two similar schools where no laptop program was present; although teacher use of technology was notably widespread in both comparison settings. Compared to their 6th grade test performance in 2006, 8th grade BWLI students averaged about 2.7 points better on the 8th grade assessment with a mean raw score of 35.6. Students in the comparison schools also improved in the 2008 assessment, although to a lesser extent than BWLI students with only a 1.3 point difference. However, comparison school students scored higher on average than BWLI students in both assessments. Results are also presented in Table SA7 for the

2006 and 2008 average Math MCAS raw scores for BWLI and comparison students. Although 11% more students “passed” the MCAS Math exam in BWLI schools in 2008 than had in 2006, the average of BWLI students raw scores decreased from 33.1 in 2006 to 31.4 in 2008, a mean drop of 1.7 points. During this same period in the comparison schools, the average 8th grade student also scored 1.4 points lower on the 2008 MCAS Math assessment than they had two years previously on the 2006 MCAS Math assessment. As also observed for ELA performance, school averages were higher for the comparison students on both the 2006 and 2008 tests than across the BWLI settings. Lastly, Table SA7 shows the average performance across all assessments for the BWLI and comparison school populations with the 143 Special Education students excluded from the analyses. The observed net gains in 2008 scores for BWLI students were diminished in both the ELA and Math subject tests when the special education students were excluded from the statistical analyses. In other words, the BWLI population as a whole saw larger net gains in both ELA and Math when special education students were kept in the 2006 and 2008 test analyses.

To summarize, BWLI students averaged a net gain in ELA scores during their two years of 1:1 laptop experience. However, so did the students in the comparison group who had only limited computer access and resources. In Math, BWLI students’ averaged lower scores on the 2008 assessment after two years of 1:1 computing (a net loss), but then again, so did the students in the comparison schools. So, to better determine if the “impact” on student achievement over the two years of 1:1 participation for 8th grade BWLI students was greater than the differences across comparison school students during the same time period, we will statistically assess how much of the net change in student performance can be possibly attributed to BWLI participation and experiences.

Student level regression models were created for ELA and Math 2008 raw scores across nearly all 8th grade BWLI and comparison students. Specifically, models were developed and analyzed to determine the overall program effect (i.e. 1:1 status) of BWLI participation on students’ test scores. Thus, the ELA regression model included 2008 MCAS ELA raw scores as the dependent variable, BWLI Status as an independent variable, and 2006 MCAS ELA raw scores as a controlling variable. BWLI status was a dichotomous variable with 1 representing a BWLI participant and 0 representing a comparison school student. The resulting equation for the 2008 8th grade ELA model was:

$$\text{Predicted 2008 ELA MCAS} = 0.764 (\text{2006 ELA MCAS}) + 1.04 (\text{BWLI Status}) + 9.83$$

The analyses found that the coefficients for both prior achievement (i.e. 2006 ELA score) and participation in the BWLI program were statistically significant ( $p < .0005$  for the ELA 2006 and  $p = .006$  for BWLI). In other words, the increase in ELA scores for BWLI students was statistically significant compared to the increase in scores observed for comparison students. Thus, we can conclude there was a statistically significant difference observed between BWLI students’ 2008 ELA test performance (after two years participation in a 1:1 computer program) and the comparison students, after controlling for prior achievement in 2006.

In addition, the current analyses also sought to look more specifically at the relationship, if any, between BWLI students use of computers during their 8th grade year and their 2008 ELA performance. Since it was suggested in the correlation analyses that BWLI students may be

using technology resources in unique and specific ways that may not be present in the comparison schools, and to aid in interpretation, the analyses of student technology practices was limited to the 579 participating 8th grade BWLI students who completed the 2008 ELA MCAS.

To this end, any of the BWLI technology use variables that had statistically significant correlations with the ELA MCAS scores (Table SA6) were entered into the regression model for 2008 ELA achievement. Specifically, the following technology use variables and scales were examined across BWLI students:

- Student computer use in Social Studies
- Student computer use in Science
- Present information scale (present)
- Recreational home use scale (recreation)
- Student perceived abilities scale (ability)

The resulting regression equation was:

$$\text{Predicted 2008 ELA MCAS} = .76 (\text{2006 ELA MCAS}) - .004 (\text{use in Social Studies}) - .018 (\text{use in Science}) + .238 (\text{present}) + .62 (\text{recreation}) + .23 (\text{ability}) + 12.12$$

Overall, this model accounted for 61% of the variance in 2008 ELA scores across all BWLI 8th grade students, however a great deal of this variance was explained solely by the 2006 scores. Specifically, after accounting for prior MCAS scores ( $p < .0005$ ) two of the student technology use predictors: *students computer use in science class* ( $p = .003$ ) and *students recreation home use of computers* ( $p = .013$ ) were observed to exhibit statistically significant coefficients.

First, a negative statistically significant relationship was found between students' frequency of computer use in Science class and their ELA achievement, even after controlling for past achievement levels and all other variables within the model. In other words, students who reported more frequent use of computers in their Science classes were found to be actually less likely to perform better on the 2008 ELA MCAS than those students who used technology less frequently for in Science during their 2007–2008 8th grade year.

In addition, a positive statistically significant relationship was also found between students' recreational home use of computers and their ELA achievement, even after controlling for past achievement levels. In other words, students who reported more frequent use of computers for recreation at home were actually more likely to perform better on the 2008 ELA MCAS than those students who used technology less frequently for recreation at home. To provide a clearer idea what types of student computer uses comprised the recreational home use scale, the original four original survey items comprising the scale included students' use of a computer to: search the Internet for fun, create music or video projects, download music or videos, and shop online. Given that BWLI student home access and use appeared largely independent of students experience in BWLI program, it was theorized that the relationship between recreational home use and ELA achievement may actually be an artifact of students socio-economic status (SES), which was previously observed to be a major correlate of student level 2008 ELA MCAS performance. In fact, the impact

and significance of students' recreation home use of computers was completely diminished when we statistically controlled students' socio-economic status, as measured by the SES scale (see Appendix A). Thus, the positive impacts associated with home recreational use and variance accounted for in the 2008 ELA model was a by-product of students' socio-economic status. This result suggests that when students SES is statistically controlled, as well as their 2006 scores, there was no difference in the impacts of recreational home computer use on 2008 ELA achievement.

None of the other individual or scaled student technology uses were found to be statistically significant in the ELA model, once prior achievement scores were controlled.

8th grade student results were also examined for Math achievement. The Math regression model included 2008 MCAS Math raw scores as the dependent variable, BWLI Status as an independent variable and 2006 MCAS Math raw scores as the controlling variable. Again, BWLI status was a dichotomous variable with 1 representing a BWLI participant and 0 representing a comparison school student. The resulting equation for the 2008 8th grade Math model was:

$$\text{Predicted 2008 Math MCAS} = 0.77 (\text{2006 Math MCAS}) + .75 (\text{BWLI Status}) + 7.05$$

As expected, students' prior MCAS scores continued to be a major statistically significant predictor variable of 2008 MCAS scores ( $p < .0005$ ). However, students' participation in the BWLI program was not a statistically significant predictor of the 2008 MCAS scores ( $p = .086$ ), when students' prior (pre-1:1) scores were also taken into account, as had been observed for ELA performance. Thus, there was no statistically significant relationship found between students' participation in two years of a 1:1 computer program and Math standardized test performance.

In addition, the current analyses also sought to look more specifically at the relationship, if any, between BWLI students' use of computers and Math performance. To this end, any scales or variables that had significant correlations with the BWLI Math MCAS scores (Table SA6) were entered into the Math regression model below. In addition, since the correlation between BWLI students' 2008 MCAS Math performance and multimedia home use was very close to statistically significant, it was included in regression model as well. In total, the following technology use variables and scales were examined:

- Student computer use in Reading/ELA
- Student computer use in Math
- Writing and research at school scale (writing)
- Present information using computers scale (present)
- Multimedia use at home scale (multimedia)
- Recreational home use scale (recreation)
- Student perceived abilities scale (ability)

The resulting regression equation was:

$$\begin{aligned} \text{Predicted 2008 Math MCAS} = & .85 \text{ (2006 Math MCAS)} + .016 \text{ (use in Reading/ELA)} + \\ & .028 \text{ (use in Math)} - .304 \text{ (writing)} - .289 \text{ (present)} + .528 \text{ (multimedia)} + .607 \text{ (recreation)} \\ & + .030 \text{ (ability)} + 2.79 \end{aligned}$$

Overall, this model accounted for 43% of the variance in 2008 Math scores across all BWLI 8th grade students, however the great majority of this variance was explained solely by the prior scores. Specifically, across all of these predictor variables, only the 2006 Math raw scores ( $p < .0005$ ) was found to be statistically significant predictor. In addition, *student use of computers in Math class* approximated a statistically significant coefficient with 2008 Math performance outcomes ( $p = .09$ ), but fell just outside the established criteria for statistical significance. However close, all of the predictor variables investigated fell shy of being classified as statistically significant predictors Math performance, after prior achievement scores were controlled.

In conclusion, the statistical analyses of student-level MCAS results revealed some positive, yet far from unanimous, results on the impacts of the BWLI program on student learning as measured by the state standardized assessment. In terms of overall program impacts, 1:1 student score increases across BWLI settings were found to be statistically greater than increases in the non-1:1 settings for ELA achievement but not for Math during the final two years of the BWLI implementation. When examining the specific relationships between the BWLI students use of technology in school and at home, nearly all of the individual and scaled technology use measures failed to result in statistically significant relationship on the ELA or Math scores, once student prior achievement was accounted for. However, in the ELA MCAS model, students' frequency of use in Science class during the 2007-2008 school year was found to be a negative predictor of ELA performance, while recreational home use was related to net score gains. The net score gains observed for recreation home use in Math was determined to be an artifact of student socioeconomic status, rather than the impact of specific home technology uses. In the Math model, students' frequency of computer use in both Math and Reading class were found to be positive predictors of Math performance, however both fell below criteria established for determining statistically significant impacts.

In this analysis of school level and student achievement data, we have explored the impact of BWLI participation and likely technology practices on student achievement using the state standardized assessment as a common metric of student performance in BWLI and comparison settings. However, the educational technology literature and the models themselves suggest that perhaps the MCAS may not be the most sensitive or appropriate measure of student achievement in 1:1 settings. To more fully explore the limitations of the MCAS as an outcome measures, we conclude our analyses of student achievement with the results of a randomized computer writing study conducted across all BWLI 7th grade participants in Spring 2008.

### ***Computer Writing Study Results***

In an attempt to get a better understanding of the relationship of 1:1 computing and student technology uses on student achievement, the research team devised and carried out an additional

study of students writing ability. Specifically, this study addresses concerns raised in previous research that students who have grown accustomed to writing using word processors may be at a considerable disadvantage when demonstrating their “true” writing ability in traditional paper and pencil assessments (Russell & Plati, 2001; Russell, 1999; Russell & Haney, 1997). As summarized in the *Methodology* section of this paper, the BWLI computer writing study randomly assigned all 7th grade BWLI students to complete a realistic MCAS extended writing test over two 45 minute sessions in Spring 2008. A total of 388 essays were collected from students in the “computer” environment while 141 essays were collected on paper before being transcribed and scored by a team of trained readers. Each essay was given two scores by separate raters on both Topic Development and Standard English Conventions. A summary of student performance across the computer and paper testing conditions is presented below across BWLI settings in Table SA7.

**Table SA8: Comparison of 7<sup>th</sup> grade results for students completing an MCAS essay using their BWLI laptop or traditional paper/pencil**

| School Name           | Condition       | Topic Score | Conventions Score | Word Count | n          |
|-----------------------|-----------------|-------------|-------------------|------------|------------|
| Conte Middle School   | Computer        | 7.0         | 5.6               | 517        | 50         |
|                       | Paper           | 6.6         | 4.7               | 309        | 26         |
| Herberg Middle School | Computer        | 7.0         | 5.5               | 324        | 144        |
|                       | Paper           | 7.3         | 5.9               | 336        | 45         |
| Reid Middle School    | Computer        | 7.6         | 5.7               | 366        | 85         |
|                       | Paper           | 6.0         | 4.9               | 257        | 56         |
| St. Mark              | Computer        | 7.9         | 6.1               | 545        | 30         |
|                       | Paper           | 6.9         | 5.9               | 362        | 14         |
| <b>ALL</b>            | <b>Computer</b> | <b>7.2</b>  | <b>5.6</b>        | <b>388</b> | <b>310</b> |
|                       | <b>Paper</b>    | <b>6.6</b>  | <b>5.3</b>        | <b>302</b> | <b>141</b> |

Table SA7 shows the comparison of 7th grade results for BWLI students across the computer writing study. After two years of 1:1 computing in school, 7th graders who participated in the computer writing study showed that students wrote both longer and more highly scored open response essays when using their laptops than students responding to the same prompt using traditional paper and pencil. To control for any pre-existing differences between the computer and paper students, 7th grade open response scores from the “official” paper/pencil ELA MCAS were used as a covariate to account for students writing ability in a traditional testing environment. Using a general linear model, we statistically “controlled” for paper-tested writing scores while evaluating the impact of computer use in testing conditions that allowed students to use their laptop and word processor rather than paper and pencil.

When controlling for students respective performance on the paper/pencil MCAS writing assessment, both the Topic Development and Standard English Conventions score difference observed between laptop students and paper/pencil students were found to be statistically significant. Specifically, after controlling for students Topic Development score on the 2008 paper/pencil MCAS, students Topic Development score was substantially higher for those students who completed the essay using their laptop than for the paper students ( $F=4.79$ , sig. .029 Adjusted  $r^2 = .203$ ). To a somewhat lesser extent, after controlling for Standard English Conventions score on the 2008 paper-based MCAS, students Standard English Conventions score was also greater for those students who completed the essay using their laptop than for the paper students ( $F=4.67$ , sig. .031, Adjusted  $r^2 = .122$ ). Given these results, it is clear that BWLI students, after using a laptop across their 6th and 7th grade years of middle school, performed better across both writing scales when allowed to complete the writing assessment using their BWLI computers.

These results highlight the challenges of measuring the impact of students and schools where technology has been adopted and widely used. These results also suggest that increasingly tech-savvy students may be at a considerable disadvantage to demonstrate their writing ability on official state assessments, which are exclusively paper and pencil in Massachusetts. Obviously, further complications are likely when the paper/pencil state test results are used to demonstrate the effectiveness of investments and programs involving computer based technologies.

Lastly, the frequent teacher sentiment in the educational technology literature that students are more motivated and engaged to compose lengthier and more developed essays when using a computer was substantiated by the BWLI computer writing study results. After controlling for Standard English Conventions score on the 2008 paper MCAS (word count is not reported in the official MCAS), the number of words students composed was still found to be substantially greater for those who completed the essay using their laptop than using traditional paper and pencil ( $F=19.95$ , sig.  $< .001$ , Adjusted  $r^2 = .256$ ). Specifically, students who completed the writing assessment using their laptop produced an average of 388 words compared to 302 words for the essays composed on paper across all BWLI settings.

## Endnotes

- 1 Endnote 1 appears in the report section titled, “Results: Student Survey”.
- 2 The MCAS data reproduced in Figures SA1 through SA5 was obtained directly from the Massachusetts Department of Education ([http://profiles.doe.mass.edu/state\\_report/mcas.aspx](http://profiles.doe.mass.edu/state_report/mcas.aspx)). It should be noted the computation rules used to determine students MCAS performance levels was changed by the state in 2006 so that absent students were no longer automatically assigned the “Warning/Failing” performance level. For the data presented in this and all subsequent figures, the 2006 scoring rules were applied to all post-2003 data. Any data from 1998 through 2002 has the former (pre-2006) rules applied; although the difference between the old and new rules in these results is likely less than one percent.
- 3 The subject tests offered annually by the state have changed somewhat over the ten-year history of the MCAS. For the 8th grade Massachusetts students, the math test was offered each year while the science test was offered from 1998 until 2000 and again resumed in 2003. In 2001, the ELA exam was moved to 7th grade, so no MCAS ELA was offered at Grade 8 from 2002 until 2005 when it was reintroduced to fulfill requirements of the federal No Child Left Behind Act.