Evaluation Plan

The Impact of Ubiquitous Computing on Middle School Learning Environments: An Evaluation in the Seventh Year of 1:1 Laptops at Norwood School

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Contents

A. Introduction

This document is a plan for assessing the impact of ubiquitous computing at Norwood School. It includes background information, the purpose for evaluating, an extensive literature review with annotated bibliography, and a plan of operation with timeline for the evaluation. This document was prepared by Demetri Orlando who is employed full-time at Norwood School as educational technology specialist and webmaster.

In the educational setting u*biquitous computing* refers to 1:1 access to computers (with internet connectivity and peripheral devices) available whenever needed at school, home, and elsewhere for students and teachers. We use *laptop program* in reference to schools using laptops. Laptops are also known as *notebook computers;* and with the advent of pen-based computing, the term *tablet* is also used. Laptop programs take several forms ranging from mobile carts shared among classrooms to full 1:1 implementations (like the one at Norwood) in which all students have access to their own personal laptop at all times. Another implementation of ubiquitous computing uses thin-client computer terminals wherever needed at school, and provides access to the same network resources for home computers through a web browser.

B. Background

Laptop Program Origins in American Schools

As early as 1997 certain independent schools in the U.S. began implementing 1:1 student laptop programs in conjunction with Microsoft's "Anytime Anywhere" learning initiative which was inspired by the success of laptop schools in Australia (Johnstone, 2003). Several public school districts around the country have implemented similar programs, and more recently entire states have begun laptop initiatives including: Maine, New Hampshire, Florida, Virginia, and

Michigan (Barrios, 2004, pp. 32-33). Many of these early adopters chose to begin their implementation in middle school grades. A well-publicized case is Maine, which in 2002 began equipping all 7th and 8th grade students and teachers with laptops (Silvernail, 2004). In September 2004, Hewlett-Packard began implementing a 1:1 tablet program for 6th graders in Michigan (Spooner, 2003). Given the large amount of money and resources devoted to technology in America's schools, stakeholders question the educational impact of this expenditure. Since many schools are now engaged in ubiquitous computing (Bartels, 2004), empirical data on its effects over multiple years are emerging.

Norwood School Description and Demographics

Norwood School is an independent K-8 school, with 500 students located in Bethesda, Maryland. Students are drawn from Bethesda, Potomac, and surrounding towns. This is the heart of Montgomery County, one of the most affluent counties in the nation. Tuition at Norwood is around $20,000/year, with about 14% of students receiving financial aid averaging $13,000 per student. The student population is quite affluent and primarily Caucasian. Students of color comprise approximately 20% of the student body. The middle school includes grades 5-8, with approximately 60 students per grade. The school is currently non-sectarian but was founded as an Episcopal parish school and continues certain rituals associated with this tradition. The student-teacher ratio is 8 to 1. The school delivers a typical curriculum enriched by strong programs in art, music, and athletics. The school seeks to place its graduates in competitive independent and public high schools in the Washington area.

Norwood School Laptop Program

The school began its laptop implementation in 1998-1999 when it added its seventh and eighth grades. Beginning in sixth grade each student leases or purchases his/her own laptop (fifth

grade has 40 laptops for 60 students). Each teacher is also provided with a school-owned laptop. All of the laptops are on a three-year lease cycle. They use Windows XP operating system and are configured with Microsoft Office, Inspiration, and a variety of educational software. Each middle school classroom is equipped with a mounted projector, tv/vcr/dvd, and document camera. Teachers have dry-erase board capture devices, but rarely use them. There is wireless network and internet connectivity for all laptops throughout the entire school. There are also mounted projectors in most meeting spaces. The school has two multimedia computer labs. All middle school homework assignments are posted to the school's web site by the teachers. All middle school students are provided with a school email address. Teachers also have a global email address book that includes all parent email addresses.

Norwood School Technology Staffing

The technology department is comprised of six people: the director of technology, network administrator, technical support specialist, database manager, help desk specialist, and educational-technology specialist. This department supports 300 laptops, 200 desktops, 14 servers, 45 printers, peripherals, PDAs, scanners, cameras, security IDs, paging system, and the extensive phone and voicemail system.

C. Problem, Purpose, & Formulated Questions

Problem Description

Norwood School is in its seventh year of a 1:1 laptop program. There are not many other middle schools in the country that have had as sustained a commitment to ubiquitous computing for this long. The result of many years of the program is a high degree of acceptance of technology in the culture of the school. Over the years, the continual improvement in computers, software, and wireless networking, coupled with teachers' increasing personal use and

acceptance of technology, has promoted increased integration of laptop activities. These successes are what sustain the program. As the program matures it overcomes certain challenges, but faces new ones. Many of the challenges have been technical in nature: transitioning to a new platform, email, and office suite; operating system upgrades; network and power cable issues; slow start-up time; adware intrusions, and network infrastructure issues. Other challenges have been more philosophic in nature: helping teachers feel comfortable as facilitators of classroom technology, internet safety concerns, demonstrating improved learning outcomes, and sustaining professional development experiences beyond the confines of discrete workshops. The combination of these challenges (technical and philosophic) has slowed the growth of the program. Once the novelty of access to ubiquitous computing has worn off, as it does after several years, and given the high cost of technology, there is a desire among stakeholders to validate the efficacy of the program. Part of this desire also stems from the recognition that some instructional time is inevitably lost to technical glitches and technical instruction.

Purpose for Evaluating

The purpose of this evaluation is twofold: 1) to document for stakeholders that program objectives are being met [see Appendix E] and 2) to provide information about the program to the faculty and administration in order to improve the program's effectiveness. As such, this evaluation contains both summative and formative elements, but is primarily summative in nature. Two previous evaluations of the laptop program were conducted; one by an evaluation consultant in 2000, and one by a school employee in 2002 [see Appendix A for summaries]. This evaluation, like the two previous, seeks to assess the overall impact of the laptop program on the learning environment in the middle school. The intent of this evaluation is to document the current successes and challenges of Norwood's ubiquitous computing program.

Formulated Question

The evaluation will seek to answer the following formulated question: *How does seven years of ubiquitous computing impact the middle school learning environment?* Specific areas to be examined in this context include: student engagement, information-fluency, project-based learning, communication, collaboration, inquiry, individualized learning, and classroom culture. Specific questions to be asked include:

- Does a mature laptop program result in students with sustained levels of engagement with subject material?
- Do teachers perceive a shift in the culture of the school's pedagogy towards more project-based, inquiry-oriented, self-directed, and individualized learning activities?
- Does electronic communication continue to increase collaboration among students and teachers?
- Are students increasing their fluency with information?

D. Limitations & Assumptions

Evaluating the impact of ubiquitous computing on quantitative learning outcomes like test scores is beyond the scope of this plan. While it is hoped that laptops will lead to gains on test scores, that is not the primary purpose of the laptop program, nor the bar against which it is being measured at Norwood School. The self-stated goals [Appendix E] of the school's technology program are more intangible elements (not as easily measured as test scores) which include promoting inquiry, collaboration, communication, engagement, and critical thinking. Bob Johnstone (2003) in *Never Mind the Laptops* says, "What's important is the kind of learning kids do using the technology. Creativity, autonomy, persistence, risk-taking: such desirable qualities cannot be taught (or tested)" (p. 7).

This evaluation will be limited to grades five through eight, collectively referred to as *the middle school*. Based on previous survey data this plan assumes that nearly all of these students have home computers with internet access. There may be 1-5% who do not have home computers with internet access, but these students may bring home their school laptops to overcome this difficulty. It is also the policy of the school to provide internet access from home in cases of financial need.

E. Stakeholders

The stakeholders in educational-technology at Norwood include all of the students, teachers, administrators, and parents. In the middle school there are about 240 students (60 students per grade). There are approximately 40 teachers who teach classes to these grades. The technology department (responsible for implementing and providing technical support) is a primary stakeholder. The author of this report, the school's educational-technology specialist, is most involved with the educational implications of the program, and therefore has a recognized conflict of interest in conducting this evaluation. As such, this plan shall include safeguards for creating objective and reliable data collection instruments. All survey and interview questions shall be prescreened by not less than three persons (teachers or parents) not affiliated with the technology department.

It is my intention to publish the results of this evaluation on the school's web site so that teachers, administrators, students, and parents have the opportunity to read and digest the results. This evaluation is not intended to provoke any specific decisions in regard to ubiquitous computing at Norwood; rather it is intended to serve as a vehicle for dialogue around how best to improve the program. If the evaluation data continues to support the notion that laptops promote

engaged and inquiry-based learning, this lends further support to the program. If the evaluation discloses areas in need of improvement, it may aid that process.

F. Literature Review

The impact of ubiquitous computing on learning environments is not always clear, and raises questions about student-centered learning, constructivist pedagogy, and whole-school reform efforts. It is hoped that a review of the research literature will clarify this picture.

Data Collection

There have been many research studies on the general use of educational technology since the advent of k-12 school computing in the early 1980s. There are fewer research studies focusing on the outcomes of ubiquitous computing because this is a more recent and less prevalent implementation of educational technology. Many of the research studies on non-ubiquitous programs were included in this data collection because they have helped frame discussion around this topic, and since the capabilities of computer labs (or limited access to classroom computers) are equaled or exceeded by 1:1 solutions. Similarly, studies on technology in elementary schools, high school, and colleges were included because their findings may be applicable to middle school.

Several periodical databases were queried using the terms *laptop, notebook, tablet, computer, middle school, technology integration,* and *meta-analysis* in various combinations. The databases included: Education Full Text from WilsonWeb, Eric from EBSCO Host, Science-Direct from JSTOR, and Digital Dissertations from ProQuest. Google was also used to locate publicly available research documents from state and federal departments of education, foundations, and industry groups.

This literature review attempted to gather the most current studies examining 1:1 classroom computing. Of the 37 articles included in this review, 18 are from 2003 or 2004. It was also the intention of this review to gather a comprehensive list of research studies and meta-analyses, which is why references have been included for older studies including Schacter's 1999 report which summarizes major research to that date. While the relevance of these earlier studies is less direct to this evaluation's formulated question, the earlier studies deserve credit for framing the discussion around the impact of technology on learning environments. The majority of included articles are from the *Journal of Research on Technology in Education*.

Interpretation of General Research on Educational Technology

The general trends in the literature on educational technology indicate clear positive effects on students' engagement, motivation, and word-processing skills (Goldberg, Russell, & Cook, 2002; Kulik, 1994; Lewis, 2004; Lowther, Ross, & Morrison 2003; Valdez, et al, n.d.; Waxman, Lin, & Michko, 2003). There is also evidence that with certain implementations educational technology has a positive impact on students' problem-solving, decision-making, and higher order thinking skills (ACOT, 1998; Barron, Kemker, Harmes, & Kalaydjian, 2003; Hopson, Simms, & Knezek, 2002). Research into individual content areas including mathematics, reading, and science have found small positive effects on achievement with various implementations of technology (Fleming & Raptis, 2000; Kulik, 2003; Matthew, 1997; Schacter, 1999a; Schacter, 1999b; Sivin-Kachala & Bialo, 2000; Soe, Koki, & Chang, 2000). There is also positive evidence on the impact of educational technology for students with learning challenges (Harris & Smith, 2004). Evidence regarding impact on standardized test scores is inconclusive (ACOT, 1998; Rockman, Walker, & Chessler, 2000).

There is some conflicting evidence in some of these areas. For example, Nichols (1996) found no significant differences in the overall quality of student writing composition when using word processors. In Kulik's (2003) summary of research he notes findings of no significant impact from some ILS (instructional learning system) reading comprehension applications.

No literature was found which identified negative educational impacts of technology implementations. However, in his book *The Flickering Mind,* Todd Oppenheimer (2003) rebuts many of the studies presented here noting the lack of objectivity of industry-employed researchers and state departments of education who have invested great sums of money in educational technology. Much of Oppenheimer's evidence is anecdotal, but his general point, that the money could be better spent, is well-worth considering. Oppenheimer also raises the point that some of the positive results might be attributed to whole-school reform efforts surrounding technology, rather than a causal relationship from the technology itself.

Interpretation of Research on Laptop Programs

Research focusing specifically on laptop programs has similar findings to the more general research. Lowther, Ross, & Morrison (2003) report that middle school students using laptops showed significant gains on writing assessments and problem-solving tasks. There are also reports supporting the positive impact on student engagement and motivation (Rockman, 2000; Russell, Bebell, & Higgins, 2004; Silvernail & Lane, 2003). Laptop programs also appear to promote shifts toward more student-centered and inquiry-based learning (Fairman, 2004; Nicol & MacLeod, 2004; Silvernail, 2004; Yang, 2002). There are also cautionary reports, such as a study prepared for Athens Academy (in its fourth year of student laptops) which states, "We also continue to see only modest changes in teaching and learning activities on the overall level and have been able to detect few effects in terms of achievement and performance" (Hill,

Reeves, Wang, Han & Mobley, 2003, p. 52). It is interesting to note that Northfield Mount Herman School, one of the earliest adopters of student laptops, decided in 2002 to discontinue its laptop program in favor of a thin-client solution (Next Generation Technology, n.d.). Although laptop implementations have the advantage of allowing computing while traveling, thin-client solutions offer the advantage of eliminating the need to carry around a relatively heavy device (the laptop) from place to place every day.

Barrios (2004, p. 23) cites evidence from the Henrico County, Virginia, laptop program that indicate educationally significant gains on Virginia's state assessment tests. Other studies conclude little or no effect on state assessments. For example, Lewis (2004) writing about a Florida laptop initiative from 1998-2001 indicated no significant impact on state assessments. Similar null results were reported for Maine in October, 2004 *eSchool News* ("Test scores fuel Maine laptop debate," 2004, p. 29). It seems there is little evidence to suggest that laptop programs alone will result in gains on standardized tests.

Most of the department of education reports (both state and federal) mention "21st Century Skills" as a goal of laptop initiatives (Barrios, 2004; Dickard, 2003; National Ed-Tech Plan, 2000). The core of these skills is identified by Rockman (2003) as "the ability to learn independently, collaborate with peers to accomplish work, and communicate the conclusions of your work" (p. 27). These goals imply higher-level thinking skills which are not necessarily measured by standardized tests.

Literature Review Conclusions and Proposal

This literature review shows evidence supporting the assertion that well-conceived implementations of middle school ubiquitous computing will positively impact student engagement, word processing, and 21st century skills. Impact on specific learning outcomes is

less conclusive and seems dependent on differential factors including the teacher's level of expertise, software design, and program implementation. Several reports have noted positive gains on specific subject-area content. Standardized test scores do not generally indicate positive (or negative) effects from laptop programs alone. Advances in equipment, professional development, and program implementations may eventually lead to measurable gains on standardized test scores, but in the shorter term we are faced with stakeholders questioning the efficacy of ubiquitous computing initiatives. In order to address these concerns for stakeholders at Norwood School, it would be useful to gather more data on how the learning experience of middle school students has been impacted. Specifically, to what extent does ubiquitous computing result in learning experiences which are more engaging, individualized, and inquiry-based?

G. Evaluation Design & Procedures

This evaluation will use surveys, observations, interviews, and focus groups to gather data describing the impact of the laptop program on learning environments. This evaluation is primarily summative in nature because the laptop program is in its seventh year and the evaluation data will be compared against that from the previous studies, and will be used to document whether program objectives are being met. Unfortunately, there is no baseline data from a control group of non-laptop middle school classrooms; however, several of the teachers who will be surveyed have experience in both laptop and non-laptop environments.

This evaluation uses both quantitative and qualitative instruments, but will rely most heavily on qualitative data. In particular, teacher responses to survey, interview, and focus group questions will provide the bulk of the data. All evaluation activities will take place during the school day.

Instrumentation and Sampling

1. *Online Survey*: self-reporting surveys are being created online for each group of stakeholders (students, teachers, parents). The surveys include both Likert-response and open-ended questions. These questions will be reviewed by at least three teachers or administrators prior to implementation. The survey will also be field pre-tested on a small group of stakeholders prior to implementation. The surveys use skip-logic to progress through a variable set of questions depending on the respondent's answers. The survey is anonymous, and a password will be applied to ensure only the evaluation participants have access to it. [Plan evaluators may view the teacher survey and examine the questions at: http://www.surveymonkey.com/s.asp?u=52209736921. See Appendix D for a screenshot of the survey and questions.] The link to this online survey will be emailed to all 40 teachers, and reminder emails will be sent until at least 20 respondents have been recorded. Similar surveys with questions targeted to students and parents will also be deployed.
2. *Interviews*: teachers and students will be interviewed one-on-one by either the educational-technology specialist or the director of technology. It is anticipated that qualitative data will be captured in session notes. Interviews will be recorded or videotaped if the participants agree. See Appendix B for interview questions. These questions will be reviewed by at least three teachers or administrators prior to implementation. These questions will also be field pre-tested on a small group of stakeholders prior to implementation.
    a. *Teachers*: In order to gain reliability, the evaluation will gather interview data from at least 15 of the 40 teachers involved in middle school. These 15 teachers shall include all of the homeroom and advisory teachers – those with the closest ties to students in these

grades. These interviews will last 20 minutes. Access to these teachers is not an issue, because they are required to meet with the ed-tech specialist when necessary.

b. *Students*: Eight students from each grade will be interviewed. Four boys and four girls. These students will be selected through random sampling (every fifth student on class list). These interviews are expected to last about 10 minutes each.

3. *Focus Groups*: Three separate meetings will be held for teachers, students, parents. These groups shall consist of not less than five persons per group. These sessions shall be recorded on videotape. Please see Appendix B for focus group questions. These are the same questions used for the interviews – addressing them in a focus group may draw out the issues or create consensus around important themes. The focus groups will be formed by open invitation to the community with RSVP. Since the groups will be self-selecting they may not comprise a reliable sample. [The benefit of creating random samples for focus groups is not deemed to be worth the extra effort because in this situation the main purpose is just to extend the interview process to a group process.]
4. *Observations*: In order to gather quantitative data on laptop usage, the evaluator [the ed-tech specialist] will circulate around the 15 academic middle school classrooms for each period of the day during two random days of each week for a duration of four weeks. The evaluator will tally the number of classrooms involved in a laptop activity (where the students are touching the laptops), as well as technology-assisted lessons in which the teacher is touching the technology. The evaluator will also rate the nature of the activity, the students' level of engagement with the task, and the level of collaboration [see Appendix C for rating scales]. Most students are familiar with the ed-tech specialist stopping in for visits, so it is not a concern that his presence would significantly alter the behavior of the students. At the

beginning of this four week period, the teachers will be told that if the ed-tech specialist visits their rooms it is because he is gathering data for his graduate studies on the types of projects that are occurring.

Data Analysis

The teacher and student survey results will be collated by the online survey software. These results will be downloaded to an Excel file and presented in graphical format for each question. Responses to open-ended questions will be combined into categories of response type. Interview and focus group responses will also be categorized and recorded by response type. These responses will be analyzed for common language, words, themes, and viewpoints. Percentages of response-types will be determined.

Dissemination

A written report of evaluation findings will be prepared for the school administration. The report will include tables with all of the open-ended question responses (both positive and negative), collated by category, and all of the quantitative data. The report shall contain conclusions and action items based upon evaluation data. Upon approval from the administration, this report (or an amended version) shall be posted to a public location on the school's web site, and stakeholders will be notified by email of its publication. If interviews or focus group discussions result in positive insightful anecdotes, and if the participants (or in the case of student, their parents) agree, these videos may also be published to the web site.

H. Time Line – Plan of Operation

The data collection portion of this evaluation is intended to take four weeks to complete. Two weeks of data analysis and wrap-up are anticipated, followed by results submission and publication. The following table illustrates this timeline:

Week	Objectives	Goal Attainment Measure
1	• Emails with links to online surveys sent to all stakeholders. • Interviewing begins • Observe classroom activity for 2 days	• Response rate at online survey site has 20 responses • Complete at least 5 teacher interviews and 10 student interviews • Record data for 2 days of observations
2	• Interviewing continues • Observe classroom activity for 2 days • Publicize dates for focus groups	• Complete at least 5 teacher interviews and 10 student interviews • Record data for 2 days of observations
3	• Interviewing continues • Observe classroom activity for 2 days	• Complete at least 5 teacher interviews and 10 student interviews • Record data for 2 days of observations
4	• Focus groups meet • Observe classroom activity for 2 days	• Focus group notes recorded • Complete at least 10 student interviews • Record data for 2 days of observations
5	• Data Analysis	
6	• Data Analysis	
7	• Submit results to administration for approval to disseminate & publish	• Results published to web site
8	• Meet with stakeholders to discuss evaluation results	• Faculty meeting discusses results

I. Resources

This evaluation plan should not incur any costs to the school because the survey software is already owned, and the ed-tech specialist who will conduct the survey is an employee of the school. The technology department budget will cover any miscellaneous items such as small prizes as incentives for participating in the survey and interviews. The main “resource” to be considered is the teachers’ time involvement in the study. Teachers already feel overburdened and lacking time for any extra duties, therefore administrator approval in support of this plan will be important.

Annotated Bibliography

Authors in boldface denote studies dealing specifically with 1:1 laptop initiatives.
*Items marked by an asterisk are research summaries, reports, or meta-analyses.

ACOT (1998) Apple classrooms of tomorrow. Retrieved 10/23/04 from Apple Computer web site: http://www.apple.com/education/k12/leadership/acot/library.html

- A 13 year research effort sponsored by Apple Computer, it is included in subsequent meta-analyses. Schacter, J. (1999) summarized the ACOT results, saying technology integration, "appeared to result in new learning experiences requiring higher level reasoning and problem solving, although the authors claim this finding was not conclusive…The ACOT experience did have a positive impact on student attitudes and did have an impact on changing teacher practices toward more cooperative group work and less teacher stand-up lecturing."

Barrios, T. (2004) Laptops for learning: Final report and recommendations of the laptops for learning task force. Retrieved 10/23/04 from Florida Educational Technology Clearinghouse web site: http://etc.usf.edu/L4L/Report.pdf

- This recent report from the Florida Laptops for Learning Task Force presents a comprehensive review, analysis, and recommendations regarding the implementation of laptop programs in k-12 education.

Barron, A., Kemker, K., Harmes, C., & Kalaydjian, K (2003). Large-scale research study on technology in K-12 schools: Technology integration as it relates to the national technology standards. *Journal of Research on Technology in Education 35(4),* 489-507.

- "In comparisons across subject areas, statistically significant differences were noted when teachers used computers [with their students] as a research tool or as a problem-solving/decision-making tool."

Bartells, F. (2004). Independent school student laptop programs. Retrieved 11/1/04 from Learning With Laptops web site: http://www.learningwithlaptops.org/Subject_Reports/SLPs_by_state.htm

- Comprehensive list of independent schools with laptop programs.

Bebell, D., Russell, M., & O'Dwyer, L. (2004). Measuring teachers' technology uses: Why multiple-measures are more revealing. *Journal of Research on Technology in Education 37(1),* 45-63.

- Findings recommend measuring teachers' technology uses in multiple discrete ways noting the lack of correlation between factors which have in the past perhaps been assumed to be correlated, such as a teacher's personal use of technology in relation to his/her classroom implementation of technology use.

Colburn, L. K., (2000). Integrating technology in your middle school classroom: Some hints from a successful process. Retrieved 10/23/04 from *Reading Online*, International Reading Assoication web site: http://www.readingonline.org/electronic/elec_index.asp?HREF=/electronic/colburn/index.html

- Reports on 1996-1999 observations and interviews with middle school students and teachers with 5 desktop computers per classroom; and identifies general themes for effective integration. Teachers note "students' sense of ownership of their learning."

Demb, A., Erickson, D., & Hawkins-Wilding, S. (2004). The laptop alternative: Student reactions and strategic implications. *Computers & Education, 43*, 383-401. Retrieved 10/23/04 from JSTOR Science-Direct database.

- Reports survey results on college students' reaction to a laptop initiative in the context of: academic success, study habits, faculty use, development of learning community, and personal use.

*Dickard, N. (Ed.) (2003). The sustainability challenge: Taking ed-tech to the next level. Retrieved 10/23/04 from The Benton Foundation web site: http://www.benton.org/publibrary/sustainability/sus_challenge.html

- Makes 10 recommendations for sustaining educational technology including: accelerate teacher professional development, professionalize technical support, implement authentic assessments, bridge home and school environments, and share best practices.

Fairman, J. (2004). Trading roles: Teachers and students learn with technology. Retrieved 10/23/04 from Maine Education Policy Research Institute web site: http://www.usm.maine.edu/cepare/mlti.htm

- "The author's findings suggest that the introduction of laptops may have the potential to encourage significant and rapid shifts in the role of teachers and students in classroom learning, as well as supporting broader improvements in teaching and learning. Teachers have begun to see themselves as partners in learning with students and report a more "reciprocal" relationship with students. Teachers also report that they are shifting toward more student-centered and inquiry-based approaches, where students take more responsibility for their learning and teachers serve as facilitators." (p. iii)

Finn, S. & Inman, J. G. (2004). Digital unity and digital divide: surveying alumni to study effects of a campus laptop initiative. *Journal of Research on Technoloy in Education, 36(3)*, 297-313.

- Reports positive statements by Grove City College alumni from classes of 1997, 1998, and 2000 in support of a campus laptop initiative.

*Fleming, T., & Raptis H. (2000). A topographical analysis of research, 1990-99. *Teacher Librarian*, 27(5), 9.

- Notes some positive outcomes for math problem solving, reading comprehension and word study.

Garthwait, A. & Weller, H. (2004). Two teachers implement one-to-one computing: A case study. Retrieved 10/25/04 04 from Maine Education Policy Research Institute web site: http://www.usm.maine.edu/cepare/mlti.htm

- A case study of the approaches to technology integration by two middle school teachers in the Maine Laptop Initiative noting, "Laptops have an educational place in both classrooms, even though they are pedagogically situated differently." (p. 4)

*Goldberg, A., Russell, M, & Cook, A. (2002). The effect of computers on student writing: A meta-analysis of studies from 1992 to 2002. *Journal of Technology, Learning, and Assessment*, 2(1). Retrieved 11/1/03 from the Journal of Technology, Learning, and Assessment web site: http://www.bc.edu/research/intasc/jtla/journal/v2n1.shtml

- "The results of the meta-analyses suggest that on average students who use computers when learning to write are not only more engaged and motivated in their writing, but they produce written work that is of greater length and higher quality." (p. 2)

Harris, W. J. & Smith, L. (2004). Laptop use by seventh grade students with disabilities: Perceptions of special education teachers. Retrieved 10/25/04 04 from Maine Education Policy Research Institute web site: http://www.usm.maine.edu/cepare/mlti.htm

- "This study used a mail survey to examine special education teachers' perceptions of the use and impact of 1:1 laptop computers provided to seventh grade students with disabilities and their teachers by the Maine Learning Technology Initiative (MLTI). Overall, special education teachers viewed the laptops as highly beneficial to their students with few exceptions." (p. 2)

Hill, J. R., Reeves, T. C., Wang, S-K, Han, S. & Mobley, M. (2003). The impact of portable technologies on teaching and learning: Year four report. Prepared for Athens Academy. Retrieved June 5, 2004 from http://lpsl.coe.uga.edu/Projects/AAlaptop

- Reports on laptop use at Athens Academy in middle and high school from 1999-2003. "Although we continue to find generally positive attitudes toward the entire laptop initiative among both students and teachers, we also continue to see only modest changes in teaching and learning activities on an overall level and have been able to detect few effects in terms of achievement and performance." (p. 52)

Hopson, M. H., Simms, R. L., & Knezek, G. A. (2002). Using a technology-enriched environment to improve higher-order thinking skills. *Journal of Research on Technoloy in Education, 34(2),* 109-119.

- Technology-enriched classrooms finds positive impact on 5th and 6th grade students (N=166) higher-order thinking skills. Study population was from a suburban Texas school district during school years 96-97 to 97-98. Students were in a magnet program providing 2:1 student to computer ratio of classroom computer. Students were taught to use productivity applications.

Johnstone, B. (2003) *Never mind the laptops. Kids, computers, and the transformation of learning.* New York: iUniverse, Inc.

- Mr. Johnstone traces the history of laptop program development from its earliest days to its current incarnation. This is a detailed history of the people and companies involved.

*Kulik, J.A. (2003) Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say. Retrieved 10/23/04 from SRI web site: http://www.sri.com/policy/csted/reports/sandt/it/

- A comprehensive summary of meta-analyses and other studies assessing a variety of reading, writing, and mathematics Instructional Learning Systems. Positive effects for some implementations were found for.

*Kulik, J.A. (1994). Meta-analytic studies of findings on computer-based instruction. Retrieved 11/1/03 from the Center for Applied Research in Educational Technology web site: http://caret.iste.org/index.cfm?fuseaction=studySummary&StudyID=275

- Findings include the following: "On average, students who used computer based instruction scored at the 64th percentile of achievement compared to students in the control conditions without computers who scored at the 50th percentile. Students learn more in less time when they receive computer-based instruction. Students like their classes more and develop more positive attitudes when their classes include computer-based instruction."

Lewis, S. K. (2004). The relationship of full-time computer access to student achievement and student attitudes in middle school. (Doctoral dissertation, Florida Atlantic University, 2004) Retrieved 10/29/04 from ProQuest Digital Dissertations database.

- Quasi-experimental study found no significant impact from laptop use on SAT and FCAT (Florida Comprehensive Assessment Test) scores. Survey data did suggest that laptop students had benefits in attitudes, motivation, technology application, and improved organizational skills.

Lowther, D. L., Ross, S. M., & Morrison, G. M. (2003). When each one has one: The influences on teaching strategies and student achievement of using laptops in the classroom. *Educational Technology Research and Development,* 51(3), 23-44. Retrieved 10/10/04 from WilsonWeb database.

- 5th-8th graders (and their teachers) using laptops showed significant gains on writing assessments (+0.80) and problem-solving tasks (+0.38 to +0.76).

Mann, D., Shakeshaft, C., Becker, J., & Kottkamp, R. (1999). West Virginia's basic skills/computer education program: An analysis of student achievement. Retrieved 10/24/04 from the Milkin Family Foundation web site: http://www.mff.org/publications/publications.taf?page=155

- Studied impact in West Virginia elementary schools of access to desktop computers distributed in various ways. Findings indicated positive gains for students using an Integrated Learning System. 5th graders scores rose proportionally on Stanford 9 test…

…"Consistent student access to the technology, positive attitudes towards the technology, and teacher training in the technology led to the greatest student achievement gains." Found greater gains for students learning with computers in classrooms than in computer lab settings

Matthew, K. (1997). A comparison of the influence of interactive CD-ROM storybooks and traditional print storybooks on reading comprehension. *Journal of Research on Computing in Education*, 29(3), 263-275. Retrieved 10/30/04 from EBSCO Host Database.

- Reports statistically significant difference in reading comprehension as measured by retelling using CD-ROM storybooks.

Mills, S. C., & Tincher, R. C. (2003). Be the technology: A developmental model for evaluating technology integration. *Journal of Research on Technology in Education*, 25(3), 382-401.

- Authors developed "Technology Integration Standards Configuration Matrix" for use in assessing teachers technology integration hypothesizing that technology-fluent teachers are necessary for students to develop technology-fluency.

National Educational Technology Plan, (2000) e-Learning: Putting a world-class education at the fingertips of all children. Retrieved 10/1/04 from U.S. Department of Education web site: http://www.ed.gov/about/offices/list/os/technology/reports/e-learning.html

- Work on an updated copy of the plan can be found at http://www.nationaledtechplan.org/

*National Middle School Association. (2001). NMSA research summary #19: What impact does the use of technology have on middle level education, specifically student achievement? Retrieved 10/23/04 from National Middle States Association web site: http://www.nmsa.org/research/ressum19.htm

- A useful summary of research noting the importance of teacher involvement in technology integration, teacher capability, student home computer use, use of online resources, use of simulation software, and benefits for at-risk students.

Next Generation Technology (n.d.). Northfield Mount Herman School web site. Retrieved 11/1/04 from: http://www.nmhschool.org/nextgen/

- Describes Northfield Mount Herman School's transition using laptops to using a thin client computing solution.

Nichols, L.M. (1996). Pencil and paper versus word processing. A comparative study of creative writing in the elementary school. *Journal of Research on Computing in Education*, 29(2), 159-166.

- No significant differences were found in the overall quality of composition of students using word-processors vs. using paper & pencil, however students tended to write more when using a word-processor.

Nicol, D. J. & MacLeod, I. A. (2004). Using a shared workspace and wireless laptops to improve collaborative project learning in an engineering design class. *Computers & Education,* (in press). Retrieved 10/25/04 from Science-Direct Database.

- College engineering students using laptops and a shared network space report that the laptops, "provided a focal point for the face-to-face discussion" and a shared network space had organizational benefits.

Oppenheimer, T. (2003). *The Flickering Mind.* New York: Random House

- Comprehensive critique of research and implementations of educational technology around the country. Rebuts many of the research studies cited in this bibliography.

Prain, V., & Hand, B. (2003) Using new technologies for learning: A case study of a whole-school approach. *Journal of Research on Technology in Education, 35(4),* 441-58.

- Reports on a whole school technology reform effort from 1995 to 2000 at an Australian secondary school. Results note effects on teaching and learning environment.

Rockman, S., Walker, L., & Chessler, M. (2000). A more complex picture: Laptop use and impact in the context of changing home and school access. [3rd Microsoft AAL Report.] Retrieved 10/29/04 from Rockman Et Al web site: http://rockman.com/projects/laptop/

- The third and final report from Microsoft's Anytime Anyway Learning program examined the impact of laptop programs on constructivist pedagogy and standardized test scores. Teachers in laptop schools showed changes toward more constructivist teaching practices. Laptop students performed better on writing assessments than non-laptop students. Standardized test score comparisons were inconclusive.

Rockman, S. (2003). Learning From Laptops. *Threshold*. Retrieved 10/31/04 from Rockman Et Al web site: http://rockman.com/articles.htm

- Suggests that the standardized tests are not a good measure of the impact of laptop program effects.

Russell, M., Bebell, D., & Higgins, J. (2004). Laptop learning: A comparison of teaching and learning in upper elementary classrooms equipped with shared carts of laptops and permanent one-to-one laptops. Retrieved 10/30/04 from inTASC Boston College web site: http://www.bc.edu/research/intasc/studies/AndoverLaptop/description.shtml

- Study examines impact of 1:1 vs. mobile carts in 4th and 5th grade in Andover, Massachusetts (N=209). Observation techniques were used to gather data on student use of technology, collaboration, and teacher role. Surveys collected data on use of the technology at home. 1:1 implementations had greater use of technology, greater student engagement, more collaboration. Home use of 1:1 group showed higher rates of writing and internet searching for school purposes.

*Schacter, J. (1999a). The impact of education technology on student achievement: What the most current research has to say. Retrieved 11/1/03 from the Milkin Family Foundation web site: http://www.mff.org/pubs/ME161.pdf

- A summary of major studies to date (Kulik, 1994; Sivin-Kachala, 1998; ACOT, 1994; Mann, 1999; Wenglinsky, 1998; CSILE, 1996; & Harel, 1991). Students who used computer-based instruction scored higher on achievement tests; students learn more in less time when from computer-based instruction; students have more positive attitudes for classes that include computer-based instruction; computers did not have positive effects in all areas.

Schacter, J. (1999b). Reading programs that work. Retrieved 11/1/03 from the Milken Family Foundation web site: http://www.mff.org/publications/publications.taf?page=279

- Positive findings using reading instruction software in grades k-3 when implemented with effective criteria identified in the study.

Silvernail, D. & Lane, D. (2004). The impact of Maine's one-to-one laptop program on middle school teachers and students. Retrieved 10/23/04 from Maine Education Policy Research Institute web site: http://www.usm.maine.edu/cepare/mlti.htm

- Comprehensive report on the Maine Learning Technology Initiative (2002-2004). Notes that students use the laptops most frequently for finding information, organizing information, and taking class notes. 4 out of 5 teachers reported that students are more engaged in their learning and produce better quality work. (p. 4)

*Sivin-Kachala, J., & Bialo, E. R.. (2000). 2000 research report on the effectiveness of technology in schools, 7th Edition. Prepared for Software Information Industry Association. Retrieved 10/23/04 from SUNY Suffolk web site: http://www.sunysuffolk.edu/Web/Central/InstTech/projects/iteffrpt.pdf

- A comprehensive report which summarizes meta-analyses, large-scale studies, and individual studies on content areas to date. Notes the importance of effective software design, professional development for teachers, and that when properly implemented technology can Improve teaching and learning.

*Soe, K., Koki, S., & Chang, J. (2000). Effect of computer-assisted instruction (CAI) on reading achievement: A meta-analysis. Retrieved 11/1/03 from Pacific Resources for Education and Learning web site: http://www.prel.org/products/Products/effect-cai.htm

- A meta-analysis of 17 research studies notes that computer-assisted instruction has a positive impact on reading achievement.

Spooner, J. G. (2003). HP follows million-dollar course in Michigan. Retrieved 12/14/04 from Ziff-Davis web site: http://news.zdnet.com/2100-9584_22-5129773.html

- CNET News.com news article notes HP winning contract to supply Michigan schools with tablets.

Test scores fuel Maine laptop debate. (2004, October) *eSchool News*, p. 29

- Notes lack of improvement on Maine Educational Assessment standardized tests for laptop students

*Valdez, G, McNabb, M., Foertsch, M., Anderson, M., Hawkes, M., & Raack, L. (n.d.) Computer-based technology and learning: evolving uses and expectations. Retrieved 10/23/04 from North Central Regional Educational Laboratory web site: http://www.ncrel.org/tplan/cbtl/toc.htm

- (Date may be 1999) Conclusions note technology can make learning more interactive, enhance the enjoyment of learning, individualize and customize the curriculum, capture and stored data for data-driven decision-making, enhance collaboration among family members and school community, and improve accountability and reporting.

*Waxman, H. C., Lin, M., & Michko, G. M. (2003). A meta-analysis of the effectiveness of teaching and learning with technology on student outcomes. Retrieved 10/15/04 from North Central Regional Educational Laboratory web site: http://www.ncrel.org/tech/effects2/

- 42 studies were analyzed (N=7,000) yielding an average effect size of +.410 ($p<.001$). Differential factors examined included cognitive, affective, and behavioral outcomes.

Wenglinsky, H. (1998) Does it compute? The relationship between educational technology and student achievement in mathematics. [Educational Testing Service Policy Information Center.] Retrieved 10/23/04 from EBSCO Host database.

- Eighth-grade students who used simulation and higher order thinking software showed gains in math scores of up to 15 weeks above grade level as measured by NAEP. Eighth-grade students whose teachers received professional development on computers showed gains in math scores of up to 13 weeks above grade level. Higher order uses of computers and professional development were positively related to students' academic achievement in mathematics for both fourth- and eighth-grade students.

Yang, C. (2002). Integration of laptops into a K-12 learning environment: A case study of a science teacher in the middle school. Retrieved 10/23/04 from Eric database.

- A middle school case study identifies strategies for shifting the teacher's role from lecturer to facilitator.

Zhao, Y., Pugh, K., Sheldon, S. & Byers, J. L. (2002). Conditions for classroom technology innovations. *Teachers College Record, 104(3),* 482-515

- This study found 11 factors which affect the success of k-12 classroom technology innovations. Interplay between the teacher, the project, and the context affected outcomes.

Appendix A: Previous Report Summaries

2000 Report Summary by Consultant Scott Woodbridge

This report is the culmination of a six month evaluation process that began in January 2000 and was completed in June 2000. The purpose of the evaluation was to assess the Norwood Middle School Laptop Program. The original evaluation sought to measure the levels of laptop use and integration at Norwood School and highlight the issues and concerns of teachers, parents and children in this process. However, as data collection progressed, early analyses revealed that the scope of the assessment needed to be broadened to include an examination of the technology practices of Norwood School as a whole.

The following summary presents the general data findings from the evaluation, and a more detailed report of these results follows. Overall, the Norwood Laptop/Technology evaluation yielded rich and intriguing findings; these, in turn, prompted specific suggestions for improvement and sustainability of the program. Major findings included:

- For optimum implementation and sustainability of the Technology Program, the program goals, objectives and expectations must be continually clarified and reviewed with all stakeholders (*evolution and refinement of these goals and objectives are expected throughout the growth of the program*);
- Evaluation instruments and methods must be aligned with evolving program goals;
- Teachers and students, when administered self-reporting surveys, reported that they possess a high level of basic computer skills;
- Parents, in recent interviews, expressed that they:
  – Can specify the technological and analytical skills they wish their children to possess,
  – Applaud the Technology Program but are unclear about the approach and goals,
  – Suggest that computers be used to complement classroom activities and research,
  – Are concerned that lack of efficient keyboarding skills may reduce students' progress, and
  – Are concerned that logistics of the program (access, portability, technological problems) may impair progress;
- Teachers, in recent interviews, reported that they:
  – Recognize the value of technology within education but lack the time and direction to implement fully within their curriculum,
  – Integrate technology in powerful but isolated ways that promote value-added learning in the classroom,
  – Value their autonomy granted by Norwood School but are unclear about the Technology Program's expectations, and
  – Praise the efforts of the EdTech specialists in supporting the technology program.

Action Items:

1. To clarify goals to Norwood community (the '*stakeholders*'—administration, staff, faculty, parents and children) and align evaluation efforts with program objectives:
- Develop a Technology Framework/Plan with all stakeholders articulating the program's theory of change,

- Utilize the Technology Framework/Plan to develop teacher training and classroom activities that align with goals and objectives of the program, and
- Utilize the Technology Framework/Plan to develop evaluation instruments that align with goals and objectives of the program.

2. To sustain and improve technology program:
- Use formative evaluation results to continually adapt program activities to meet objectives and goals (or to refine goals and objectives), and
- Present evaluation findings in multiple venues to communicate findings to all stakeholders and elicit recommendations for program improvement.

2002 Report Summary by Teacher Jay Briar

The educational technology program at Norwood School is strong and continues to reinforce the overall mission of the school. Students at Norwood exhibit excellent technological skills when compared to peer schools without a like dedication to those skills, and faculty identify numerous connections between the facilities at their disposal and the quality of their lessons. The school has constructed and maintained an excellent network and hardware infrastructure and had learned how to make changes when necessary.

The current structure and capabilities can be further adapted to the needs to the faculty and students and to the capabilities of the software and hardware available on the market now and in the years to come. The fifth and sixth grade homeroom program, which allocates ten laptops to each classroom for a 2:1 student to laptop ratio, is the strongest of the programs in place, though lowering that ratio would bolster its impact on student work and learning. The seventh and eighth grade program is effective in its current deployment of one laptop assigned to or owned by student, but should be reorganized to draw some of the specific benefits of the fifth and sixth grade program, while still meeting the unique needs to students who are not in a like homeroom base.

To increase the flexibility of the program, families entering the seventh grade should be strongly encouraged to purchase a laptop, which can be accomplished through the school at a discounted rate. These laptops in combination with classroom sets in history, science, math, and foreign language classrooms would provide a more diverse environment of opportunities for teachers and would allow students to participate in the technology program at a level commensurate with their interest and ability.

New advances in networking individual use should be evaluated each year and considered for application in the Norwood program when those advances would better solve challenges faced in the classroom. Additionally, the Technology Enhancement Fund should be bolstered as a centerpiece for this exploration of new ideas.

Appendix B: Interview and Focus Group Discussion Prompts

For Teachers

What projects or activities have your students done that involved technology?

How has ubiquitous computing affected the workings of your classroom?

Do you think laptops promote engaged, collaborative, and inquiry-oriented student activity?

What technology skills do you think your students need to have?

What are the greatest challenges to using technology in your classroom?

Do you feel like you've had adequate professional development around technology?

What would you do to improve the technology program?

Can you describe how your students search for information, organize it, and manipulate it?

For Students

What are the best and worst parts of the laptop program at Norwood?

What projects or activities can you remember doing that involved technology?

Do you think laptops activities are engaging, collaborative, and inquiry-oriented?

What technology skills do you think you need to have?

What would you do to improve the technology program?

Can you discuss a project where you needed to find information, and how you used that information?

For Parents

What technology skills do you want your children to possess?

Please comment on the approach and goals of the school's laptop technology program…

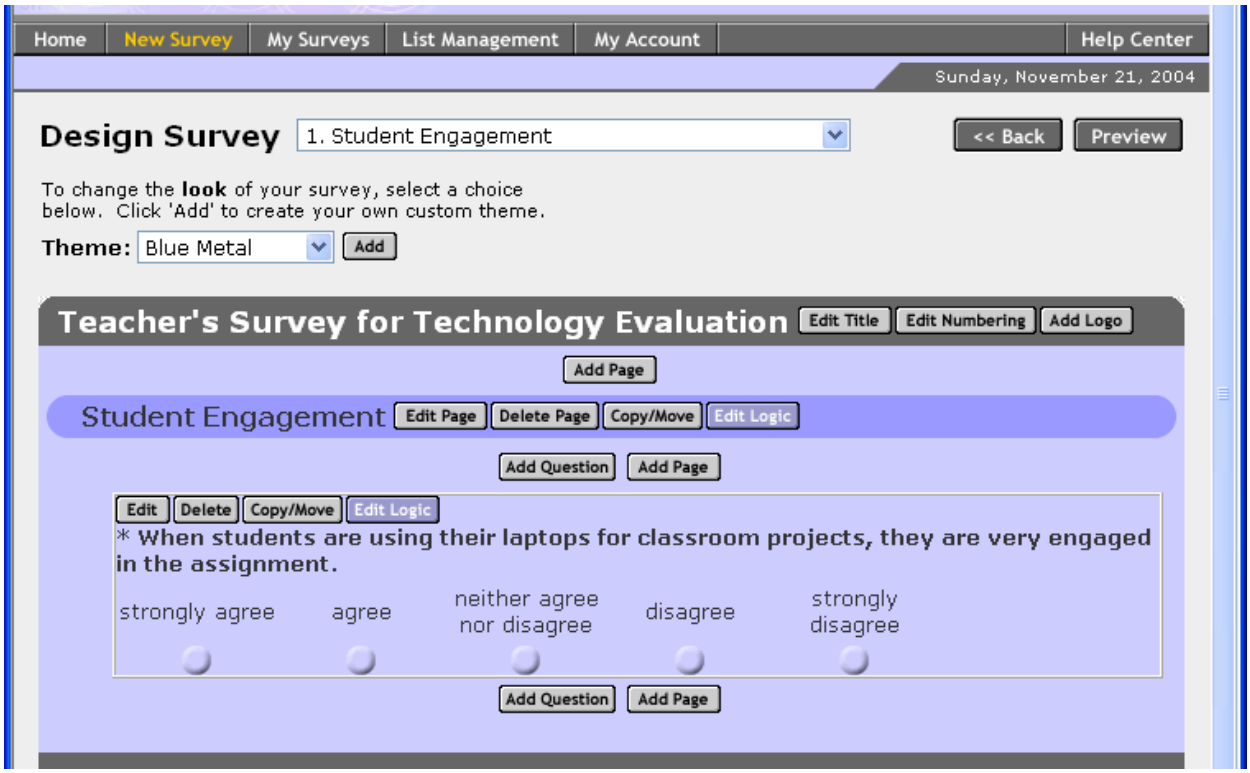
What suggestions do you have for improving the school's technology program?

Appendix C: Rating Scales (for classroom observations)

Students Touching The Computers	**Only Teacher Using The Computer**
Nature of Thinking Skills 1. Low: searching and retrieving information; word processing. 2. Medium: gathering/organizing/analyzing information, creating charts, presentations. 3. High: evaluating information, creating compelling communications/presentations.	Nature of Thinking Skills 1. Low: displaying information. 2. Medium: analyzing information. 3. High: evaluating information.
Engagement 1. Students seemed bored and inattentive. 2. Students are somewhat involved, but not very interested. 3. Students are engaged, but not necessarily with the task at hand 4. Students are engaged with the task at hand 5. Students are very engaged.	Engagement 1. Students seemed bored and inattentive. 2. Students are somewhat involved, but not very interested. 3. Students are engaged, but not necessarily with the task at hand 4. Students are engaged with the task at hand 5. Students are very engaged.
Collaboration 1. No collaboration is taking place 2. Some students are collaborating, but not necessarily on the assignment. 3. Some students are choosing to collaborate on the assignment. 4. Many students are collaborating on the assignment. 5. All students are engaged in collaboration on the assignment.	Collaboration 1. No collaboration is taking place 2. Some students are collaborating, but not necessarily on the assignment. 3. Some students are choosing to collaborate on the assignment. 4. Many students are collaborating on the assignment. 5. All students are engaged in collaboration on the assignment.

Appendix D: Example of Online Survey Design.

This survey is previewable at: http://www.surveymonkey.com/s.asp?u=52209736921



Survey Questions:

Likert: When students are using their laptops for classroom projects, they are very engaged in the assignment.

> For disagree responses: Which of the following influenced your answer to the previous question most:

Likert: The laptop program has resulted in increased levels of electronic communication between students

> For agree responses: Why is this?

Please check the boxes for the types of communication you know your students are using:

> Norwood Email Accounts, Personal Email Accounts, Instant-Messenger Accounts (AOL, Yahoo, etc.), Chat Rooms (AOL, Yahoo, etc.), Other (please specify)

Please comment on your perceptions of the impact of the laptop program on your classroom. Consider the following elements: project-based and inquiry learning, self-directed and individualized learning.

Please comment on technical glitches or hurdles you or your students have encountered.

Appendix E: Norwood Educational Technology Goals

[Excerpted from 2003 Technology Plan]

Norwood uses technology to support the instructional objectives of the curriculum. With proper forethought and planning, technology-infused lessons engage students, create innovative learning experiences, and help students learn. From the teacher's perspective, technology enables unique instructional capabilities and efficiencies. The following taxonomy of goals speaks to one fundamental mission: that technology should extend, enrich, and illuminate learning.

- **Individualized Learning**: Support and accommodate the individual needs and diverse learning styles of Norwood's student body with personalized instruction and assessment. Help learners visualize problems and solutions. Provide supplementary or primary means to acquire, practice, and reinforce course content, with evaluation and feedback through tutorial software and supplementary electronic materials.
- **Information Management**: Teach students to create, manage, and organize information, thereby enabling meaningful interpretation and presentation of facts, concepts, and ideas. Link learners to learning tools including: word-processing, spreadsheet, and database applications; tutorials, and computer-assisted-instruction. Provide teachers with fast and versatile methods for gathering, sharing, and manipulating information, and for tracking student learning progress. Provide tools for students to create maps, timelines, diagrams, graphs, and images in support of their writing and research. Improve students' organizational skills for file and information management.
- **Inquiry**: Facilitate student exploration and discovery, and improve the means by which they access, analyze, and evaluate information. Link learners to digital information and education sources including primary source documents, real-time data, and global visual / audio sources. Use simulation software for experiments and places not otherwise available to students.
- **Writing, Research, and Presentation**: Support and improve the writing process: brainstorming, outlining, note-taking, drafting, revising, editing, reviewing, and publishing. Improve the consistency of how the research process is taught and conducted through all nine grades and within each of the grade level homerooms. Improve students' oral and electronic presentation skills.
- **Engagement and Motivation**: Gain students' attention and increase perception of being in control of their learning. Engage students through creative production work using multimedia or multisensory experiences. Allow students to pursue more than one path in learning. Enable students to take risks. Enable interactivity and immediate feedback/assessment.
- **Communication**: Increase use of synchronous and asynchronous communication technologies to interact and share knowledge with others as a means of learning more about the world, thus preparing students for life outside the classroom, in an increasingly connected world. Communicate with experts, foreign language speakers, and other audiences.
- **Collaboration**: Provide tools for cooperative and collaborative learning experiences, both local and distant, facilitating students working in teams to solve problems.
- **Critical Thinking, Problem Solving, and Decision Making**: Promote student use of technology to evaluate information, test ideas, and increase knowledge for solving real-world problems using higher level thinking skills.
- **Appropriate and Ethical use**: Teach students to use technology tools and digital resources in an ethical manner. (See the appendix for the School's Acceptable Use Policies.)
- **Lifelong Learning in the Information Era**: Encourage students to take an active role in their own learning by choosing tools which aide them in problem solving and which facilitate their own pursuit of knowledge. Required skills for the information age include technology literacy, information literacy, visual literacy, and team work.