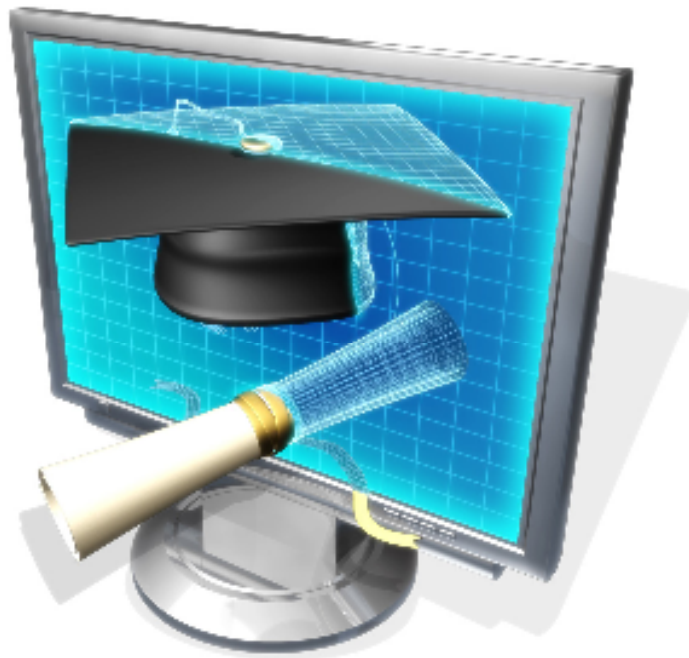


# **Medford Public Schools Technology Committee Report**

**April 13, 2011**



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# Medford Public Schools Technology Plan

## Mission

The mission of the Medford Public Schools is to provide all students with the cognitive and affective skills to be a successful and responsible 21st century citizen in the global workplace and community. An integral part of this mission is to provide our students with the most effective methods and resources to maximize the learning experience, which includes appropriate, up-to-date technology.

## Vision

Teaching and learning should drive instructional technology and our goal is to implement technology that supports our learning expectations. A key to effective teaching and learning is creating environments that make learning meaningful for all students while requiring them to process content using high-level thinking skills. One powerful way to accomplish this is through effective integration of technology into our curriculum and instruction.



*Our job in schools is to teach students to be responsible citizens and in the year 2011, we cannot do this completely if we are barring students from accessing tools that will allow them to connect, collaborate, and build a positive digital footprint.*  
- Patrick Larkin, Burlington High School Principal

In today's society, the typical student uses a variety of electronic devices for both entertainment and productivity, from TV to smart phones to computers to game consoles. We can build a classroom which engages students by capitalizing on this environment. Students are attracted to and feel empowered by technology; we suggest building upon this natural affinity through the use of technology to produce outstanding learning outcomes. Students show an interest in online content; we suggest that with the proper guidance

and context, this curiosity can be channeled towards meaningful instruction.

Preparing students to be college and career ready requires 21st century learning that extends beyond simply teaching the basics. Students can be empowered with the skills and attitudes to communicate, think critically, and collaborate to create solutions to real world issues. The students of today can become the leaders and informed participants of tomorrow.

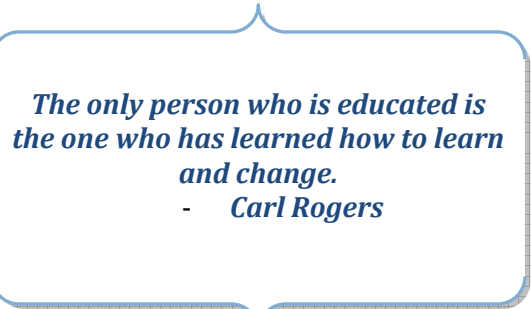
## Goals

This technology plan reflects the district's vision, goals, and objectives for teaching and learning, and the role that technology should play in implementing the district's goals. The plan is intended to provide direction for the School Committee, superintendent, administrators, teachers, support staff, parents, and students in designing the effective integration of technology in our schools by increasing student engagement; improving

differentiated instruction; and developing 21<sup>st</sup> century skills such as digital citizenship, creativity, problem solving, collaboration and critical thinking.

Medford Public Schools can achieve this vision in part by adopting proven instructional methodologies such as project-based learning, inquiry based learning, and constructivist learning which support differentiated instruction and inspire students through active and engaged learning. While it is possible to adopt these learning strategies without technological supports, their effectiveness is multiplied through the judicious application of computer-based instructions and supports for educators to utilize them well.

Technology opens doors and allows access to and engagement in learning for students with a wide range of learning styles, needs and interests. Think for a moment about how a student who is gifted in academics may perform in school and what she needs to engage in learning, then think about the student with cognitive delay, or autism, or about the student for whom English is a second language, or the student who struggles to get C's and D's, or the student who is blind, or the student who misses school frequently due to medical issues, or the student who is living in a homeless shelter, or of course the "average" or "typical" student. As a public school system, it is our responsibility to educate each and every one of these students despite differences in skills, abilities, needs, learning styles and interests. We must be able to stimulate interest and motivation for all students. We must ensure that all students with all of their diversity are able to access learning and express what they know.<sup>1</sup>



*The only person who is educated is the one who has learned how to learn and change.*  
- Carl Rogers

Driving this change will be teachers empowered by access to new tools and online resources, along with the training necessary to integrate these resources into the curriculum. Students, too, will have the access they require to connect beyond the classroom as they take ownership of their own learning. The Medford classroom will become a microcosm of the world in which we live, where access to information and the technology required to filter, organize, and create it are readily available.

A child starting kindergarten in the fall of 2011 will be graduating from high school in 2024 and college in 2028. We have a responsibility to prepare these students, as well as our current students, for the future NOW.

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<sup>1</sup> There are three important concepts that, when implemented, help us to meet the needs of diverse learners: universal design for learning (UDL), differentiated instruction (DI) and assistive technology (AT). Technology has been described as the great equalizer because it is through technology that we are able to provide learning materials that are accessible to all. For more information on UDL, DI, and AT please see Appendix 4.

## **WHAT IS - THE CURRENT STATE OF TECHNOLOGY IN MEDFORD SCHOOLS**

Our present curriculum is based on a teacher-centered learning model versus a more effective, dynamic, student-driven pedagogical model. Students tend to be passive participants and not truly engaged in the learning process. Our research (see appendix 1) indicates that Medford Public Schools teachers would like to develop a more student-centered, engaging classroom but are restricted by the emphasis on content and limited resources, including technology. Instructional resources in these classrooms are limited and include whiteboards/chalkboards, paper textbooks, pencils, paper, and outdated computers.

### **Status of Instructional Hardware and Software**

The newest student computers in the district can be found in the Viewing Room at Medford High School, which contains twelve computers that were donated by Tufts University in 2008. Unfortunately, the majority of classroom/cluster computers are no longer in use, and the labs at the high school are outdated and need upgrades. Computers in the library were donated by the Department of Correction in 2006 and aren't compatible with technology students bring from home, such as USB drives and papers written in newer versions of Microsoft Word. Further, the operating systems on these machines prevent the updating of browsers and other application software which prevents students from accessing web sites or the software altogether.

The technology at our "new" schools is actually quite old and is hindering students and teachers alike from using technology effectively. The viable life of hardware is six years<sup>2</sup>, yet the technology (software, computers, monitors, printers, LCD projectors) is presently 11-years-old at the McGlynn and Andrews schools and 10-years-old at the Brooks, Columbus, and Roberts schools.

At these schools, the computers are running an old operating system, Windows 2000, which is no longer supported by Microsoft or other software companies including Adobe (Reader, Flash, and Shockwave) or Oracle (Java). Due to the lack of support and the inability to upgrade computers, these schools have suffered a serious setback in the ability to utilize educational websites. In addition, users do not have the ability to attach newer educational devices (Mimeo boards, webcams, and even some USB drives) as the old operating system will not support them.

While Medford High School did implement a partial refresh plan three years ago, the allotted bond funding the MHS upgrade was inadequate and did not address all of the school's hardware upgrade needs. Instructional computers at the High School and Vocational School were purchased in 2000; these machines are now approaching eleven years of high use, and suffer from many of the same problems of machines half their age.

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<sup>2</sup> as determined by the Department of Elementary and Secondary Education.

The age of the hardware has also taken its toll as our vendors scramble to assist us in procuring parts for 10-year-old machines. We have also lost the ability to use spare parts from old machines as we have depleted our supply. This year, it took three months to receive replacement fans for computers while vendors searched all inventories.

All machines at the new schools are running Internet Explorer 6 and cannot be updated to IE 7 or 8 due to the old operating system, thereby limiting applications and websites. Applications such as Adobe Flash, Reader, Shockwave, and QuickTime can no longer be updated on Windows 2000. Most sites used by the students require these updates. Therefore, the number of web sites used by teachers and students is quickly diminishing. Due to the out of date operating systems, online testing and assessment required by the Department of Education is currently not possible.

Lack of dedicated and sustained technology funds severely limits the purchases of new hardware, parts and supplies across the boards. For instance, fifteen percent of elementary and middle school hard drives fail per year; each replacement drive costs \$42.00, but repairs are limited by the \$2,000.00 tech budget for the year. Similarly, LCD projectors are failing due to their advanced age. In several instances, the bulbs used in these machines are no longer available. LCD projectors and printers are not cost effective to repair, so teachers must share resources.

In perhaps the most dramatic example of the condition of school computers, power buttons on the computer faceplates are no longer operable on 15% of the computers in our elementary and middle schools. The Technology Department must have holes drilled into the faceplates by the Vocational School and the computers are then turned on by using a pencil eraser.

It has become increasingly more difficult to teach to the digital future when our state of technology is in the past.<sup>3</sup>

## **WHAT SHOULD BE- THE FUTURE OF TECHNOLOGY IN MEDFORD SCHOOLS**

Through project-based learning and other engaging instructional methodologies, students can attain 21st century skills that align with our district goals, including Medford High School's 21st Century Learning Expectations<sup>4</sup>, which promote the development of critical thinking skills, the appropriate use of technology for learning, collaboration, presentation, research, and design, the ability to identify credible information sources online, and demonstrated ability to produce digital content.

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<sup>3</sup> For a detailed list of computers and students per school building please see Appendix 2

<sup>4</sup> See appendix 3.

Our goal is to design a technology plan that prepares our students to become college and career ready in the 21<sup>st</sup> century. We have included a list of key elements of this plan:

*The art of teaching is the art of assisting discovery.*  
- *Mark Van Doren*

- Technology must be seamless and not interrupt the flow of learning: it should be easy to use, provide anytime, anywhere learning (mobile, online, etc.) with less time spent on how to do something with a particular software application and more time using the technology to support learning; and teachers and students must have everything they need, including proper cords, up to date software and applications, internet access, and appropriate technology.
- The network must be robust, with both wired and wireless access allowing students and teachers to utilize their devices and the internet throughout the district for anywhere, anytime learning, collaboration, and research. (For more on network considerations please see Appendix 5)
- Technology must increase student engagement, encourage curiosity and help students become active, self-directed learners. Included in this expanded call for engagement is providing access to all learners through universal design for learning strategies.
- Technology and instruction that allow students to collaborate in diverse groups to share knowledge, build consensus, achieve goals, and learn how to communicate effectively should be implemented.
- We should prepare students for lifelong learning by using and understanding technology tools and resources appropriately for collaboration, presentation, and research.
- We must expand online learning for students and staff professional development both within the district and with others.
- We must require students to be responsible users of technology and show them how by modeling this ourselves.

### **One device per child:**

One-device-per-child, or one-to-one computing (1:1), has been shown to be a key component to 21st century learning; we recommend providing laptops or tablet computers to every student. Many school districts have done this, including entire states such as Maine, Texas, Pennsylvania, Illinois, Michigan, South Dakota, and Indiana, and local communities such as Windham, NH, Millis, TechBoston Academy, Westfield, Chatham, and Easthampton, and several others are in the planning phases, including Burlington,

*Technology can help meet the needs of different intelligences, different learning styles and different learning paces.*

*- Beverly High School  
1:1 initiative*

Winthrop, Beverly, Natick, and Plymouth, to name a few. Approximately 24% of all school districts with student populations of more than 2,500 are planning 1:1 laptop initiatives.<sup>5</sup>

Increases in attendance, improved test scores and decreases in behavior problems are some of the findings from studies of successful implementations of one-to-one computing in schools where students use computers for 80% of the school day. In these schools, students use computers for internet-based research, communication

with teachers, individual and group projects, submitting and retrieving assignments, and homework.

Additional advantages attributed to 1:1 computing include increased student engagement (reflected in improved learning and retention), improved student organization, the ability to customize student instruction, and better communication between student, educator and parents.

Studies have found that to successfully implement one-to-one computing, computers must be regarded as an essential tool to facilitate learning rather than a separate add-on to the existing curriculum. Considerations must be made to the redefinition of curriculum in terms of what gets taught and how it gets taught with a focus on classroom investigations and collaboration that can develop deeper understandings of underlying processes.

Similarly, the implementation of a more technology-centric approach to education requires an extended phase-in plan, allowing stakeholders such as faculty, students, and parents to articulate their concerns. While any systemic change can be challenging, the transition towards more hands-on, research-intensive and immersive learning through technology is in the best interest of the students of Medford.

## **The 21<sup>st</sup> Century School:**

### **Classrooms**

All students will have access to an array of devices (e.g. laptop, workstation, tablet computer), iTouch, etc. via wireless internet. The teacher will have a computer workstation, projection capability, interactive capability, wireless internet access, instructional applications (APs) from the internet or on devices and a mobile device similar to the students in the classroom.

Using project-based learning or other methodologies, all students will be engaged in classroom activities, interacting with their classmates as well as with the teacher. The

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<sup>5</sup> [America's Digital Schools 2006: A Five Year Forecast, a report by the Greaves Group and the Hayes Connection](#)

teacher will have the ability to monitor all devices to ensure that students are on task. Students will have access to unlimited sources on the internet and instructional applications/programs. Teachers will require students to use these resources to create projects/presentations that demonstrate the attainment of 21<sup>st</sup> century learning outcomes.

For example, a history instructor might assign students to research the particulars of the Battle of Lexington and Concord. In addition to traditional text-based information, students might take a virtual tour of the area via Google Earth, or work in teams to produce a video reenactment of the event, or view primary sources available through the Library of Congress web site. Assignments may be uploaded to a common website for peer evaluation, teaching students the value of helpful versus hurtful criticisms. Final projects may be shared online in a blog site, providing students an opportunity to learn how to present themselves and their work to a broader audience.

### **Library/Media Center**

At the very heart of a 21<sup>st</sup> century school where technology is seamlessly integrated into the learning process is the School Library Media Center. Different from the classroom, whose focus is on specific instruction and directed tasks, the library is the place where faculty and students can find resources in multiple formats with help from the Teacher Librarian or Media Specialist and the Technology Integration Specialist.

The model 21<sup>st</sup> century school library features a robust wireless internet connection and networked computers for student use; multifunctional work stations that can be moved to accommodate groupings/classes of various sizes as well as tables and seating areas for reading, class discussion, video conferencing, and presentations; and semi-private kiosks/spaces for online coursework and self-directed study.

### **Computer Labs**

In a wired school, the computer labs will not be used as intensively, freeing them up for more specific tasks, such as administering state, federal AP and other tests, conducting professional development workshops, or having a language lab. The computers in these labs can also have special software for specific purposes, such as digital editing for art, music, and video students, Computer Aided Design (CAD), or a particular application for science class, for example.

### **The 21<sup>st</sup> Century Teacher:**

#### **Professional Development**

A critical element in this process is a comprehensive professional development plan. In order to attain the learning expectations of the technology plan, classroom teachers and administrators must be able to incorporate technology in their instruction.

During the spring and summer of 2012, professional development will be offered to faculty and staff in several ways:

- Initial training from vendors
- Ongoing throughout the school year (after school workshops, professional development days, etc.)
- Train the trainer model; staff available to help others
- Online courses and workshops
- Collaboration with other districts

## **HOW TO GET THERE**

### **Technology plan timeline:**

In March of 2010, a technology advisory committee comprised of teachers, administrators, parents, and community members was created to develop a district refresh plan. In addition, advisory groups of teachers and students were formed in the 2010-2011 school year to solicit feedback on proposals. After months of research, presentations by technology companies and visits to other school districts, the committee has developed a technology refresh plan for the school district. The primary goal of the committee was to create a plan with technology as the centerpiece that supports the development of 21<sup>st</sup> century skills in all students so they are both college and career ready.

In April, the plan will be presented to the School Committee for their review and approval. With the support of the School Committee, the technology committee will present the plan to the City Council for consideration for funding through a bond.

With the approval of the bond funding, by June the technology committee will create proposals and seek quotes from vendors found on the state contract list. In order to ensure that the proposals are accurate, cost effective and meet our instructional criteria, we will have the proposal reviewed by a technology consultant company from the state contract list. The vendor quotes will be reviewed by the technology committee and technology consultants.

In the fall of 2011, with the selection of the vendor(s), a timeline for installation of the network, equipment, and materials will be developed. In the spring and summer of 2012, we anticipate the installation of the new network, equipment and materials so the technology will be operational by September of 2012 for the opening of school.

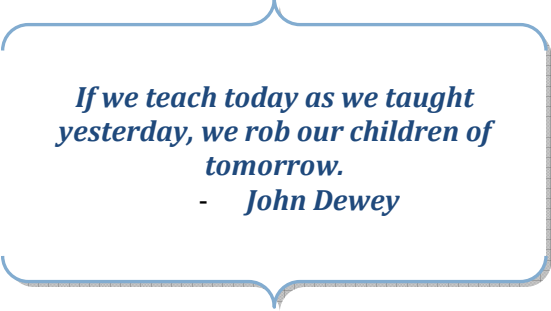
### **What is the cost of doing this?**

At this point in the process, it is difficult to accurately ascertain the price of implementing this plan: variables include specific hardware and software expenses, infrastructure upgrades, etc. The instructional devices, software and access will be age appropriate. The

specific details of a 1:1 implementation such as what device to use cost to the school and parents, insurance, and a timeline that allows for professional development and other important preliminary steps are currently being considered. The technology committee is conducting research, speaking to and visiting 1:1 school districts, and soliciting feedback from faculty, staff, students, and community members. (See appendix 6)

Some of the cost of this expenditure will be offset by savings through using free or low cost internet applications for instruction, fewer textbooks to purchase and replace, less paper consumed by printing out exams and instructional materials, lower maintenance and materials costs for district printers, students staying in district and not leaving for charters/parochial schools, etc. <sup>6</sup> Since communication and assignments are electronic, there will little need to print or copy documents. In one-to-one solutions, student devices will be charge at home and run on battery power in school. Digital “textbooks” will be developed locally or by staff and other resources can be used at little or no cost (e.g. websites, online videos, etc.)

### **What is the cost of *not* doing this?**



*If we teach today as we taught yesterday, we rob our children of tomorrow.*  
- *John Dewey*

We are not providing our students with a 21<sup>st</sup> century education with outdated technology. We must empower our students by providing devices and resources to allow them to be creative thinkers and problem-solvers, preparing them for college and the challenges of the modern workplace. Teachers and administration do not have the instructional tools to create the learning environment needed to achieve this

goal.

The cost of upgrading our technology increases the longer we wait. We are at the point where most of our technology, particular at the K-8 schools, is so old it is marginally operable and in many cases can't be repaired because the hardware and software are no longer supported by our vendors.

Massachusetts Department of Elementary and Secondary Education will require online testing of our students in near future. Due to age of our equipment and software, the present technology is not able to be used for this purpose.

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<sup>6</sup> “Cost reductions, improved student engagement, and better learning outcomes are all possible through the implementation of appropriate technologies. In fact, Project RED research has calculated an overall 8% cost reduction- even when hardware and maintenance costs are factored in- by using online courses, digital content, online assessment and professional development.”- [Project RED](#)

## CONCLUSION

The district mission states:

“The Medford Public Schools is a caring educational partnership of school, family and community designed to ensure that all students are afforded a safe and healthy learning environment in which they develop the knowledge, skills and attitudes to reach their full academic and personal potential. **This partnership is dedicated to providing all students with a 21st century education that will enable them to be life-long learners and contributors to a diverse and rapidly changing world.**”

*“In the end, the goal should be fostering students who are lifelong learners—not just students who have learned the formula for getting good grades in school. We want to inspire intellectual curiosity and those mental skills that students will carry with them their whole lives. That’s the most important thing.”*

*- Vikram Savkar, Nature Publishing Group*

As Medford Public Schools invests in new technology, it is critical that we make choices that maximize, rather than limit, current and future opportunities to leverage the technology for learning. The plan developed by the technology committee supports the district’s mission and goals by providing direction for the effective integration of technology that supports our teaching and learning expectations. When successfully implemented, technology is a valuable tool that can increase student engagement, support differentiated instruction, and help students become responsible and thriving digital citizens.

## **Appendix 1**

### **MPS Teacher Technology Use Survey**

- 139 staff in district took survey October 19, 2010
- All levels: elementary, middle, high school
- All content areas: math, ELL, SPED, foreign language, science, health, etc.
- All different staff members: Teachers, support staff, and administrators
- 47% favor 1:1 and see it as most effective mode of instruction over clusters of computers in a classroom, visiting a computer lab for technology instruction, or using laptop carts
- When asked what technology they want that they don't currently have access to, most wanted an LCD projector, Smartboards, and computers that function properly

### **Full results are attached**

#### **Several survey participants left comments:**

School computers run on Windows 2000 which often presents a problem as the rest of the world has moved on.

Do we even have all of these things??? cameras? reading devices?? My 10 year old classroom computers don't even work. How are we expected to use technology if all of our computers are so old they can't even support the internet?

I bought my own LCD projector because there's not enough to share in my dept.

My computer is ancient and the printer breaks down frequently. Not enough memory to install needed software.

I do use the projector often, but my primary problem is the internet. I am unable to show videos, animations, and weather maps, pertinent to my science lessons because the website do not work with our outdate browser.

I am not a classroom teacher so I do not use technology in the classroom. However I do find that sometimes I struggle with outdated software and slow computer speeds when completing my day to day job functions in special education which are highly internet based.

(i)Overhead projector does not work well. It goes on about 15-20 minutes then goes off by itself. Would like to have a more reliable OH projector. (ii)Uncertain about if one day the LCD projector light bulb went off, will there be a new one bulb available? (iii) Uncertain about if my printer cartridge ran out of ink one day, will there be any cartridge supply? Why do teachers need to worry about these things? The school should have these in stock, have enough supplies.

All of the smaller special education classes do not include the LCD projector which is an essential tool for presenting interactive and visual presentations. Not having an LCD in the classroom is an educational disadvantage for both the teacher and student.

I really need my LCD projector fixed. It no longer projects. I would love a computer that can handle today's web. It seems that every site says that our OS is outdated and we do not have access to the most current resources. I would like to Skype with people who are willing to speak with my class. I am exploring a purchase of a Samsung tablet when they are released, or possibly a netbook for my classroom.

Primary classrooms have limited educational software programs. ANYTHING would be better than what we currently have.

I currently borrow equipment &/or bring in personal equipment from home.

I don't have much access to any technology. ANYTHING WOULD BE GREAT.

I would love to use the laptop cart but many laptops don't work and they are slow. It's a huge hassle to pass them out and get them back into the cart. It's cumbersome and the numbers are not visible when the laptops are closed. Too many of them don't work and I lose about 20 minutes of class time.

## Appendix 2

Ratio of students to computers in the Medford Public Schools: 2:1

100% of classrooms and computers connected to the Internet  
100% of classrooms connected to the Local Area Network.

Medford maintains an up-to-date web site, managed by a full time Web Master, which includes information for students, teachers, parents and community members.

100% of all schools allow students to use computers before and after school.

	Students	Computers ( Includes Student & Administrative Computers)
High School	1222	429
Vocational	220	163
Curtis-Tufts	26	18
Andrews	521	391
McGlynn MS	561	337
Brooks	585	278
Columbus	515	257
McGlynn Elem	620	341
Roberts	609	272
Total	4849	2487
Total Elementary	2329	
Total Middle	1082	
Total HS	1466	

### **Appendix 3**

Medford High School's 21st Century Learning Expectations:

- Become self-directed learners.
- Communicate effectively.
- Apply problem-solving skills and develop critical and creative thinking skills
- Use technology appropriately as a tool for learning, collaboration, presentation, research, and design.
- Act with integrity, respect and responsibility toward themselves, others, and the environment.
- Exhibit flexibility and adaptability.
- Collaborate in diverse groups to share knowledge, build consensus, and achieve goals.
- Practice leadership in and service to their community.
- Become contributing citizens in a global society.

## Appendix 4

**Universal Design for Learning (UDL)** is a set of principles for curriculum development that give all individuals equal opportunities to learn. UDL provides a blueprint for creating instructional goals, methods, materials, and assessments that work for everyone--not a single, one-size-fits-all solution but rather flexible approaches that can be customized and adjusted for individual needs. Technology allows for these flexible approaches. For example, a textbook or workbook in a print format provides limited means of navigation or physical interaction (e.g., turning pages, handwriting in spaces provided). Many interactive pieces of educational software similarly provide only limited means of navigation or interaction (e.g., using a joystick or keyboard). Navigation and interaction in those limited ways will raise barriers for some learners – those with physical disabilities, blindness, dysgraphia, or who need various kinds of executive functioning supports. It is important to provide materials with which all learners can interact. Technology allows this to be possible. Retrieved from <http://www.cast.org/udl/index.html> on 3/4/10.

To **differentiate instruction** is to recognize students' varying background knowledge, readiness, language, preferences in learning and interests; and to react responsively. Differentiated instruction is a process to teaching and learning for students of differing abilities in the same class. The intent of differentiating instruction is to maximize each student's growth and individual success by meeting each student where he or she is and assisting in the learning process. Retrieved 3/7/11 from [http://aim.cast.org/learn/historyarchive/backgroundpapers/differentiated\\_instruction\\_udl](http://aim.cast.org/learn/historyarchive/backgroundpapers/differentiated_instruction_udl)

**Assistive technology** is technology that increases, improves, or maintains the functional capabilities of students with disabilities. Usually it is specifically designed to assist individuals with disabilities in overcoming barriers in their environment and in increasing their opportunities for independence in the learning process and school environment. For example, a student who has a reading disability can access electronic text that is read aloud via the computer. AT can be integrated seamlessly when technology is part of the educational environment and curriculum.

Universal Design for Learning	<ul style="list-style-type: none"><li>•All Learners</li><li>•Curriculum Level</li><li>•Proactive Instructional Design</li></ul>
Differentiated Instruction	<ul style="list-style-type: none"><li>•Classroom</li><li>•Teacher Level</li><li>•React Responsively to classroom/individual needs</li></ul>
Assistive Technology	<ul style="list-style-type: none"><li>•Individual</li><li>•Student Level</li><li>•Prescriptive, explored after problem is identified</li></ul>

## Appendix 5

### Network Considerations

The demands placed on network services and bandwidth are increasing exponentially. Examples include:

- Robust web-based educational applications and research tools
- On-line courses, including Moodle
- Medford Public Schools web-based Student Information System
- Streaming media
- Real-time monitoring and management of all servers, switches, and power regulation devices
- Real-time monitoring and recording by the District-wide Security system
- Real-time monitoring and management of District-wide building HVAC systems
- Real-time monitoring and management of the Wind Turbine resident at the McGlynn School
- District and City-wide administrative and business functions

Our present inventory includes 25 Servers, 67 Switches, 29 UPS's, and 3 Firewalls. They are distributed across 8 buildings, utilized by over 2400 PC's and printers, and accessed by over 4900 students, and 900 employees. Add to this the recommendation to offer a one-to-one ratio of students to computing devices at the high school, and the daunting task of maintaining the fast, reliable, secure network becomes apparent. Subsequent network design and topology must be able to meet the demands of the ever increasing bandwidth load, an increased density of computing devices, and unrelenting threats to the users, network security and system resources. Conceptually, this design should include:

- **Secure and non-secure network access**
  - Secure access for authenticated users utilizing authorized devices
  - Un-secure access for other users requiring Internet access only
- **Wireless and Wired Network Access**
  - Wireless access should be provided to reduce wiring costs while effectively blanketing educational and administrative areas with network access.
  - Wired networks will need to be updated where pre-existing wiring does not meet the minimum requirements or is non-existent.
- **Multiple platforms**
  - Windows: Active Directory integrated with Group Policy
    - Regulation and management of PC based devices
  - Apple/MAC: Open Directory integrated
    - Regulation and management of Apple's & Mac's
- **New Servers**
  - Deploy new servers with the latest Operating Systems and hardware sufficiently capable of handling future demands.
    - Server Virtualization should be considered to:
      - reduce the physical number of servers
      - reduce energy consumption
      - reduce the total cost of ownership
      - improve the Windows Data Center efficiency

- At present, the District has twenty-five (25) Windows-based, two (2) Linux-based, and zero (0) Mac-based servers distributed between 8 schools. These servers have been in continuous operation for as long as ten (10) years.
- **Network Switches**
  - Switches are active, intelligent devices that process and route data. They ensure that data finds its way from the source to its destination and back. With the exponential growth in data packet size and volume, the existing fleet of switches is not capable of handling the ever increasing data transmission loads.
    - At present, the District has sixty-seven (67) distributed across eight (8) schools which have been in continuous operation for as long as ten (10) years.
  - Replacement switches are required to meet the ever increasing bandwidth and technology demands.
- **Packet shaping**
  - Packet shaping technology determines how WAN and Internet resources are utilized, identifies causes of WAN and Internet performance problems, and provides a path to fix those problems. Traffic shaping technology controls bandwidth utilization and application performance by actively preventing network congestion. This technology ensures true Quality of Service (QoS) for mission-critical applications.
- **Electrical and Environmental Controls**
  - Network devices require power conditioning to protect against surge suppression and power failures. This task is performed by a total of twenty-nine (29) UPS's (Uninterruptable Power Supply's) resident in each Head End and data closet.
    - UPS's require replacement after five (5) years due to reduced battery life and potency, as well as surge suppression circuitry failure.
    - Most of the District's UPS's have been in continuous operation for as long as ten (10) years.
  - Electronic devices, especially network devices, require the ambient air temperature and air quality be controlled to prevent overheating.
    - At present, the District has 16 data closets with Air Conditioning and 7 data closets without Air Conditioning. Temperatures in the non conditioned data closets consistently register in excess of 100 degrees Fahrenheit. These extreme environmental conditions greatly reduce the Mean Time Before Failure (MTBF) of the devices resident in those closets. Each year, A/C failures and the resultant temperature extremes have caused many servers and switches to fail. The disruption to service can last for weeks, and sometimes months, until replacement servers are purchased, configured, and returned to service.
- **Increased Internet bandwidth**
  - This District's bandwidth requirements have consistently increased over the past few years. When Medford High School first went on-line, users were limited to 56Kbps modems. With the rollout of the Phase 1 & 2 schools, the network boasted T1 access with its 1.5Mbps. A fiber optic upgrade 3 years ago afforded the District 8Mbps. Last year that was increased to 20Mbps. Next year it will be increased to 30Mbps.

- Conservative estimates suggest the Districts bandwidth requirements will start at 100Mbps. Proper design and technology utilization could require twice that estimate.
- **Annual network line item in budget**
  - Recurring operational costs for maintenance, licensing, hardware replacement, and support should be included as a line item in the District's annual budget. This will address the issue of Total Cost of Ownership (TCO) by ensuring support of the various network hardware and software components over the life of the technology.
- **Costs**
  - Preliminary estimates:
    - Network Upgrades & Services: \$900,000
    - Servers: \$35,000 X 5 sites = \$175,000
    - Electrical & Environmental: \$30,000 + \$60,000 = \$90,000
    - Increased Bandwidth:
      - 50Mbps: \$137,000