COMPUTER TECHNOLOGY AND THE BEDFORD PUBLIC SCHOOLS

HOW STUDENTS USE, LEARN WITH, AND ARE SERVED BY, DIGITAL TECHNOLOGY

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INTRODUCTION

This report provides a comprehensive description of the critical role that digital technology plays in the Bedford Public Schools, both operationally and as a primary vehicle for teaching and learning. These data and their accompanying explanations demonstrate that we have arrived at a watershed period, a phenomenon in no means specific to Bedford, whereby education has become inseparable from the technology of the times, and that a well-planned ongoing investment in our infrastructure, devices and software is a necessity.

Wonderful work is being done every day by students and teachers at all four of Bedford's schools using teaching and learning tools that have been acquired through board and town approved capital budgets and operating budgets, supplemented by grants from organizations such as the Bedford Education Foundation. The lion's share of the hardware, however, was purchased via building projects, and for years the annual operating budget line item was insufficient to the task of providing the number of devices required by growing enrollment and changing program needs, while simultaneously keeping up with a responsible replacement schedule. Accordingly, our elementary schools lagged further and further behind, inheriting hand-me-down computers that were unable to function reliably. This situation was exacerbated by the long-standing practice of limiting capital expenditures to the purchase of SmartBoards and infrastructure. Therefore, four years ago and in conjunction with the town's embarking on a six year capital planning process, we assessed the actual need and successfully shifted the major cost of computer replacement to the capital budget (excluding iPads and Chromebooks, which remain a part of the operating budget). At that time we proposed that school technology's timely replacement, based upon industry standard life cycles and adjusted by regular on-the-ground assessments, would require an annual capital investment conceptually similar to, the town's commitment to maintaining our roads. When computers don't work, teachers' plans are directly impacted and valuable student learning time is wasted.

We hope that this report will help the interested reader understand how computer technologies fit into the Bedford Public Schools' educational mission and philosophy and how vital they have become to our students' intellectual growth and academic success.

COMPUTER TECHNOLOGY AND THE SCHOOLS
Bedford Public Schools
Updated, December 13, 2018

OVERVIEW

PRIMARY PURPOSE

Since digital technology has become the principal means by which organizations access, store and share information and ideas, school systems have become entirely dependent upon it. While it promises to yield certain modest cost-saving or time-saving efficiencies, when it comes to teaching and learning, cost savings are not the primary impetus for its inclusion. And while we should also see improvements in the standardized test scores of some of our struggling students, as technology enables increasing instructional differentiation, this too is not its predominant educational role. Technology's greatest promise lies in its capacity for deepening and extending student learning, in large measure by making the learning process increasingly student-centered. And, as it is the present medium for learning, working, communicating, creating and playing in our fast changing world, schools are responsible for preparing students to use it effectively and responsibly.

GENERAL OPERATIONS AND COMMUNICATION

Each teacher, administrator and secretary has a PC, or a laptop, with which he or she communicates, using **Google Sites and Gmail,** with colleagues, parents and increasingly with students. The schools are essentially paperless when it comes to memos and other forms of adult to adult communication. The number of teachers who have developed their own **web pages** to communicate with students and parents is steadily growing: about a third of our elementary classroom teachers, half of our middle school and a majority of our high school teachers. Increasingly as well, **blogs, video and various forms of social media** are used to increase communication with families and community. Emergency and other timely information is also communicated via computer directed phone links through our Alert Now system.

Our Student Information System, **Aspen**, is all digital, and as the repository of student assessment data and state-assigned student and teacher identification information (SASIDS and MEPIDS), it is the database used for mandated communications with the Department of Elementary and Secondary Education.

COMPUTER-BASED STATE ASSESSMENTS

The Commonwealth/Department of Elementary and Secondary Education plans for all MCAS 2.0 assessments to be administered using computers by the Spring, 2019. This requires not only that the District has sufficient devices to administer the tests and to do so in the least disruptive manner, but critically, that the devices are reliable.

TEACHING AND LEARNING

Planning, Assessing, Grading and Making Use of Data

All teachers develop curriculum units and plan lessons using computers. All curricula and

lessons are stored on computers. Teachers grade online. At the middle and high school level, parents access grade information online. The new generation of standardized tests is computerized.

All teachers belong to **data teams** that meet on a regular basis to collect and analyze student work and achievement data based upon common assessments. They use computers and spreadsheets to collate and sort data, examine patterns of achievement and identify reasons for low performance so that they can modify instruction and share new strategies to address the gaps. The schools also have school-wide data teams that, along with various central administration efforts, analyze larger data sets to identify learning gaps.

Vertical Tracking and Analysis of Student Achievement

The District is piloting the use of Mastery Connect, an assessment management resource that would allow the district to track and analyze student progress on a comprehensive combination of standardized and school-generated assessments across students' school careers. This would serve as a diagnostic tool, a way of providing receiving teachers important information about their students, particularly at the 2-3, 5-6 and 8-9 transition points, and way of collecting and organizing student work for ongoing student reflection.

Instruction and "Minds-on" Learning

21st century skills, such as creativity, communication, collaboration, problem-solving, and critical thinking depend upon interactive learning. Developing these abilities, learned in conjunction with course content and discipline-specific skills, comprise the core learning goals of the Bedford Public Schools. Equally important, the schools strive to develop in all students the skills and dispositions needed to become self-directed learners whose intrinsic motivation, self-awareness and "growth mindset" contribute to deeper and longer lasting learning. Hands-on and "minds-on" learning, where students work through problems, replaces passive listening where teacher "telling" once predominated. Developing students' ability to think analytically and creatively and to become self-directed learners depends entirely upon this instructional paradigm shift. While minds-on or student-centered learning does not depend upon digital technology, it significantly deepens and extends this type of learning when used appropriately when put into students' hands. It also provides access to a wider range of students who find these technologies highly engaging.

Broadening Access and Knowledge Demonstration. Instructional technology provides both students and teachers with **multiple ways to demonstrate knowledge** as they interact with content, create and present information in various formats, including text, image, sound, and video. This has added value at a time when we have come to recognize what Gardner refers to as **multiple intelligences** (visual-spatial, bodily-kinesthetic, interpersonal, musical, intrapersonal, linguistic, and logical-mathematical). In addition to building on students' unique strengths, teaching through **multiple modalities** also allows more students to more effectively access the curriculum, as some students are more adept visual, auditory or kinesthetic learners. Using computers, particularly handheld devices, in small groups enables individual learners to move at their own pace to get additional practice with skills or concepts that they find difficult to master. Brain-based Research. We know from a variety of sources (educational practice, brain research,

educational theory) that learning and long term memory are enhanced by active engagement with material. As a pattern discerner, when the brain makes connections and actively manipulates data, new neurological connections are created and learning is pushed into long-term memory. This is why we say that we *develop thinking through content*, and the best way to learn content is to have students *think about it*. Instructional technology does not facilitate this automatically, and in fact, its misuse can exacerbate a kind of "mindlessness" that runs counter to reflection and deep learning. So helping students to learn to use technology "mindfully" is a responsibility schools must now assume. Used correctly, it provides students with rich opportunities for research, for problem-solving, and for presenting their learning in creative ways.

Transforming Instruction: Metacognition, Work Curation and Portfolios. Powerfully, technology provides a vehicle that analogue systems cannot practically compete with, for developing students' **metacognition,** the awareness and understanding of one's own learning processes (planning, comprehension, etc.). As we are beginning to do in several places, students are collecting their work through Evernote, SeeSaw, Google Docs, and other software programs, and they are analyzing and commenting upon it on a regular basis. When a teacher asks students to select their best example of learning and to explain why they chose it, or when students have to compare a drawing to one done several weeks later or review their writing over a period of time, several important things happen: one, they more effectively remember important information and concepts; two, they deepen their learning of the skills or content at hand; three, they develop an appreciation for their work product and process (as opposed to the automatic mindlessness that we so often associate with homework), and finally, they develop an understanding of their own learning that creates ever greater independence. These portfolios will eventually be developed cumulatively over the span of the students' schooling. They also provide **important opportunities for assessment** that regular paper and pencil tests cannot achieve. Assessing higher order thinking, the ability to synthesize information, apply or transfer skills, and creatively problem solve increasingly require **project-based or performance-based assessments**. Accumulating and storing this student work data is only possible using digital technologies.

Transforming Instruction: More Regular Checking for Understanding. Teachers are changing the way they check for understanding in ways that ensure much greater success for all learners. Historically, teachers would ask the class if they understood a concept or they would call on a student whose hand was raised, and after the correct information was surfaced, they would move on. Many teachers have long since recognized that this type of approach does not reveal the whole class's understanding, nor does it require all students to think about the question at hand. While many teachers have used non-digital methods, like individual white boards, that engage all students' thinking and reveals all students' understanding, the new technology offers powerful new ways to do the same. Particularly when each class member has access to a device, we are seeing a more thorough integration of just-in-time assessment and other forms of immediate feedback. This feedback is not only useful to teachers, who can then adjust their instruction, but immediately to students as well, as it engages their thinking and informs them of how well they are understanding the material. Programs like Socrative immediately turn the students' answers into graphs that the teacher can project onto the Smartboard to serve as a basis for further discussion of the material.

Transforming Instruction: Just in Time Research/Increasing Literacy Skills

In keeping with our "Active Learners, Resourceful Thinkers, Effective Communicators" paradigm, teachers are building in more and more opportunities for students to research answers to either student-generated or teacher-generated questions during class. Aimed at developing students' researching skills, capitalizing on their curiosity, and increasing their engagement, the practice of posing questions that emanate from a lesson and sending students to hunt down the information virtually in order to formulate answers, is a highly impactful strategy.

Transforming Instruction: Virtual Collaboration

Whether student work groups use Google Docs to collaborate on group projects, or students communicate with peers across national boundaries through foreign language classes, digital technology in the Bedford Public Schools is providing students with real 21st Century communication and collaborative work skills.

Keyboarding

Consistent with the ever earlier use of digital devices, the District has moved keyboarding instruction to the elementary (Lane School) grades.

Programming

Beyond the robust and long-standing high school programming electives, the District began to introduce coding across the District through the Hour of Code approximately five years ago, and during the past several years, we've begun to formulate a K-12 coding sequence that will impact all students. Using Scratch software and ancillary hardware, students are doing elementary coding beginning at the Davis School. At the more advanced application level, the technology classes at JGMS and the Robotics classes at BHS are engaging students in higher order problem solving and coding solutions.

Broadening horizons. In an increasingly globalized environment, web-based technology allows for whole new learning experiences as classes communicate with "sister or brother" classes in other countries, and as individual students develop learning and social networks that transcend traditional boundaries.

Self-paced Supplemental or Remedial Learning

With the introduction of iPads and Chromebooks at the elementary schools in particular, applications are being used to enable students to engage in self-paced learning to supplement direct instruction and to provide remedial opportunities. At Davis, where the Daily Five literacy program involves students moving through learning stations, iPads provide engaging opportunities for students to read, listen to audiobooks, record their reading, etc.

Specialized Learning Labs

Whether the foreign language computer lab designed for advanced audio and speaking-related learning, the graphics lab, the music lab, the CAD lab, the several technology labs (with their 3-D printers), the Business and Computer Science labs, or the school libraries/makerspaces equipped with computers and ancillaries, our specialized learning labs provide students with a

combination of content-specific and creative problem solving learning opportunities.
Assistive Technology. Finally, some of our students require various forms of assistive technology, like text to speech software.

The Promise and the Challenge of Meeting Students Where They Are
Most students are immersed in digital technology in one form or another. Three year olds have tablets, and despite various market fluctuations, with competition between Androids and iPads, children's tablet use is on the rise. Witness Amazon, ToysRUs, Kmart kids' tablet creations, statistics coming out of the UK with one in three children owning a tablet, and the increasing use of e-readers. While their ubiquity certainly presents challenges in terms of distractibility and older students' widely held but erroneous belief that they can multitask effectively, i.e., engage in school work while simultaneously social networking, their promise for capturing and channeling students' imaginations and technological intelligence is too great to ignore.

Equally challenging is the schools' ability to sufficiently maintain its technology in order to facilitate the students' sharing of their work. Students tend to have newer versions of hardware and software and when they create work products at home (research papers, documentary videos, PowerPoint presentations) and bring them to school, teachers frequently cannot view or display them. This speaks clearly to the need to ensure the currency of our infrastructure, our devices and our software.

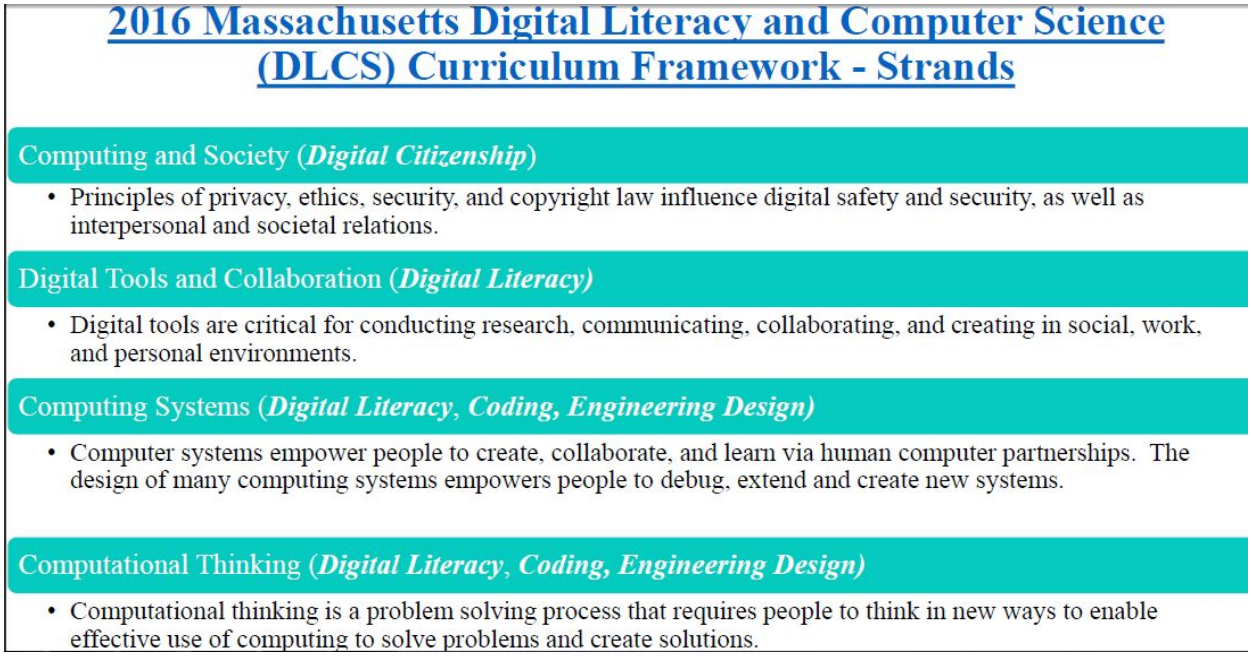
Most important, using digital technology enables educators to harness students' experiences and "speak their language" in ways that are both engaging and motivating. Teachers find that students often persist longer and even voluntarily practice exercises at home that are traditionally found to be boring and uninteresting. Harnessing the self-expression drive that social media "exploits" to engage students in expressing themselves as learners can not only increase engagement, but also deepen students' motivation and self-awareness as learners. To fail to do so is to create a false dichotomy between the media for formal, structured learning and the media with which students are already learning, either deliberately or unconsciously in their lives.

Moving Beyond Consumption
Students are consumers of technology, and while many are exceptionally adept at certain kinds of applications like gaming or social networking, and many are no so consciously engaged in new forms of communication and digital creation, most are neither well-schooled in technology's more academic, artistic or occupational uses, nor are they particularly reflective about how they use it, either as a source of information, communication or creation. It falls to the schools to meet students where they are and move them into a more reflective and discerning relationship with technology, and to equip them with the knowledge and the skills to use it productively. While, for example, many learning games are increasingly available and "teach" valuable knowledge and skills, we want our students learn how to code so that they will be able to create games themselves. We are beginning to construct a K-12 programming curriculum so that all students can understand coding as a frame of mind, as an approach to problem solving and as a kind of language. Many students are learning how to manipulate technology, how to solve technological puzzles, how to make things work. Harnessing those skills and applying them in our academic context is not only engaging for students but provides an avenue for

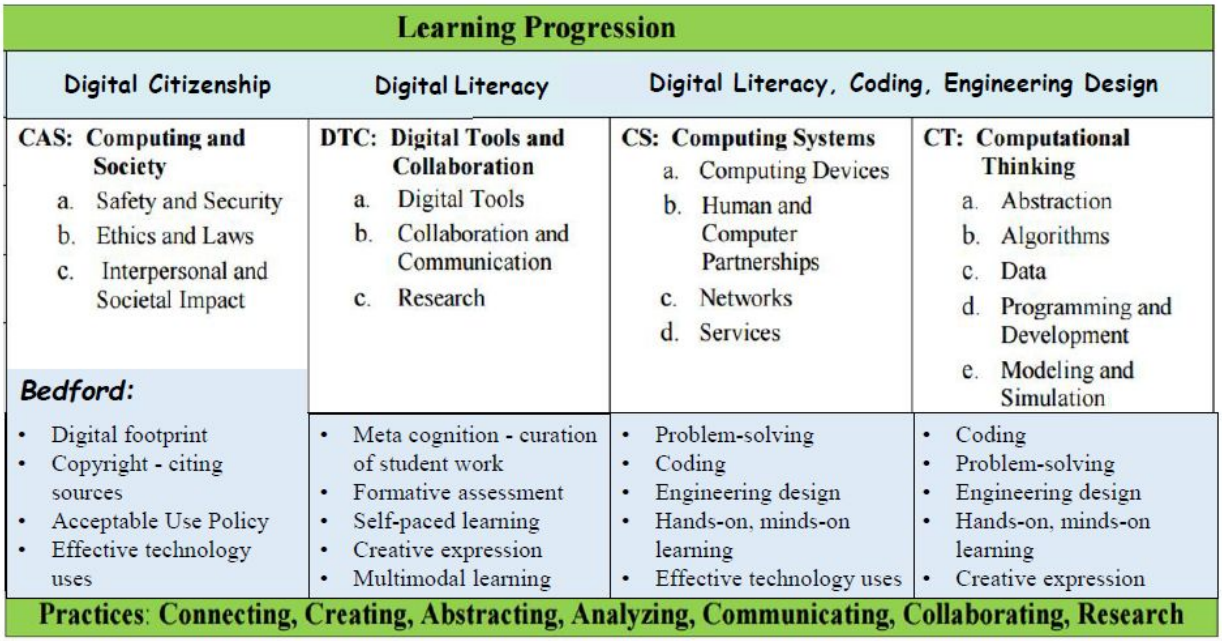
developing the
higher order thinking skills that form the core of our educational mission.

ALIGNING OUR WORK TO THE STATE TECHNOLOGY FRAMEWORKS

While Bedford has a comprehensive approach to using digital technology to advance core learning objectives and to prepare students to use technological tools in colleges and careers, we are simultaneously using the best of the Department of Elementary and Secondary Education's frameworks to advance our work. While more on this will follow, the following graphics provide an idea of how these goals overlap.



Digital Literacy and Computer Science (DLCS) Overview



Learning Progression			
Digital Citizenship	Digital Literacy	Digital Literacy, Coding, Engineering Design	
CAS: Computing and Society a. Safety and Security b. Ethics and Laws c. Interpersonal and Societal Impact	**DTC: Digital Tools and Collaboration** a. Digital Tools b. Collaboration and Communication c. Research	**CS: Computing Systems** a. Computing Devices b. Human and Computer Partnerships c. Networks d. Services	**CT: Computational Thinking** a. Abstraction b. Algorithms c. Data d. Programming and Development e. Modeling and Simulation
Bedford:			
• Digital footprint • Copyright - citing sources • Acceptable Use Policy • Effective technology uses	• Meta cognition - curation of student work • Formative assessment • Self-paced learning • Creative expression • Multimodal learning	• Problem-solving • Coding • Engineering design • Hands-on, minds-on learning • Effective technology uses	• Coding • Problem-solving • Engineering design • Hands-on, minds-on learning • Creative expression
Practices: Connecting, Creating, Abstracting, Analyzing, Communicating, Collaborating, Research			

DISTRICT-WIDE TECHNOLOGY HARDWARE, SOFTWARE AND THEIR USES

EPSON BRIGHTLINK PROJECTORS AND SMARTBOARDS: These projectors and interactive whiteboards are in every regular classroom at BHS, JGMS, Lane, and Davis. http://www.epson.com/alf_upload/pdfs/projectors/brochure_595wi.pdf

These projectors are used by teachers and students in a variety of ways. First, teachers project their lesson information, often in PowerPoint format, to provide clear visuals to accompany auditory processing. Slides, embedded video, etc. as well as animated presentations bring everything from cellular mitosis to the Civil War to life in vivid visualizations. This is helpful to the whole class, but is particularly important for non-auditory learners.

Students use the same projection capacity to display their learning and share it with the class, in the form of PowerPoints, documentary videos, etc. Both students and teachers use document cameras in conjunction with SmartBoards and Epson Projectors to display and critique student work.

As interactive platforms, they enable elementary students to solve math problems, manipulate data, and engage in a variety of learning programs such as:

- Google Earth, Google Maps and Neighborhood Map Machine for geography and social studies,
- Google SketchUp and interactive math programs consisting of virtual manipulatives for mathematics

- Socrative and Kahoot for checking for understanding and class discussion,
- Lego WeDo, NASA, Exploratorium, National Geographic for Kids for science, technology and programming,
- Stop Motion, Corefx, Tabletop Jr., Inspire Data, Kidspiration, Inspiration for writing and other forms of creative expression

While students can access these on devices like computers and iPads, the SmartBoards/Epson Brightlinks allow for whole class or group interactive learning (*See accompanying spreadsheet for software program descriptions).* Finally, the Interactive Projectors remember the information inscribed on the white boards, so students who are out for extended times can access lecture notes, etc. This is a capability that is unevenly used.

DESKTOPS: Students use desktops in computer labs for a wide range of learning activities (research, learning programs, self-paced learning programs, programming, design, composing music, written work, art work, building personal learning networks, preparing presentations, etc.), some of which can be done on handheld devices, and some of which require greater memory capacity, etc.

LAPTOPS: Laptops are used by central office administrators, administrators and teachers in each of the schools. They are used by teachers for: communicating with each other, with students and with families; planning; curriculum development; classroom instruction; student information (grading, etc.) purposes; and instruction. Administrators use laptops for communicating, planning, student information purposes and compliance reporting.

Laptop carts are used for instruction for a variety of purposes including student research, writing and editing, presentation creation, programming, lab work, etc.

IPADS and CHROMEBOOKS. iPad and Chromebook use varies from school to school and is detailed below.

LASER PRINTERS: We increased the number of laser printers across the District as we phased out the deskjet printers to save costs on ink cartridges. * *As a cost savings measure, laser printers phased out the use of deskjet printers.*

SOFTWARE

Below is a list of software that is installed on all computers in each of the schools. Additional software may be installed as well, samples of which are described below. That information can be found on the school based software tabs of this worksheet.

BHS	***JGMS***	***Lane***	***Davis***
Acrobat Reader DC	Acrobat Reader DC	Acrobat Reader DC	Acrobat Reader DC
Adobe CS3	Audacity w/LAME decoder	algodoo	Audacity w/LAME decoder
Audacity w/LAME decoder	Avervision	Audacity w/LAME decoder	CoreFX
Avervision	Flash for IE & Firefox	Avervision	Flash for IE & Firefox
Flash for IE & Firefox	Freemake	Flash for IE & Firefox	Freemake

Freemake	Geosketchpad 5	Freemake	Gimp 2.0
Geosketchpad 5	Gimp 2.0	Gimp 2.0	Google Chrome
Gimp 2.0	Google Chrome	Google Chrome	Google Earth
Google Chrome	Google Earth	Google Earth	Google Sketchup
Google Earth	Google Sketchup	Google Sketchup	Graph Club 1.5
Google Sketchup	Greenshot	Greenshot	Greenshot
Greenshot	inkscape	inkscape	inkscape
inkscape	Inspiration 7.5	Inspiration 6	iTunes
iTunes	iTunes	iTunes	Java
Java	Java	Java	Jing
Jing	Jing	Jing	Lego WeDo
Inspiration 8	Kurzweil 3000 client	Kurzweil 3000 client	Mozilla Firefox
Kurzweil 3000 client	Mozilla Firefox	Mozilla Firefox	MS Office Suite 2013
Mozilla Firefox	MS Office Suite 2013	MS Office Suite 2013	MS Silverlight
MS Office Suite 2013	MS Silverlight	MS Silverlight	NVU
MS Silverlight	Notepad ++	Notepad ++	Notepad ++
Notepad ++	NVU	NVU	Phun
NVU	Phun	Phun	Read Natually
Phun	Scratch	Scratch	Scratch Jr.
Scratch	Shockwave	Shockwave	Shockwave
Shockwave	Skype	Skype	Skype
Skype	Smartboard/Smart Response	Smartboard	Smartboard
Smartboard	Storybook	Storybook	Stationery Studio
Storybook	Studio MX	Symantec EndPoint	Storybook
Symantec EndPoint	Symantec EndPoint	Tessellation	Stationery Studio
VLC Player	VLC Player	TimeLiner 5.0	Symantec EndPoint
Windows Media Player	Windows Media Player	VLC Player	VLC Player
		Windows Media Player	Windows Media Player

SCHOOL- SPECIFIC HARDWARE, ADDITIONAL SOFTWARE AND USAGE

BEDFORD HIGH SCHOOL

DESKTOP DISTRIBUTION AT BHS

High School	Desktops	Total Number: 242
Art Lab	Desktops	20
C104 & C114 (STEP)	Desktops	4
C108 (Programming Lab)	Desktops	30
C109 (Drafting Lab)	Desktops	20
D101 (Music Lab)	Desktops	21
D106 (ESL)	Desktops	6
E201 & E208 (Skill Center)	Desktops	8

Foreign Language Lab	Desktops	28
Guidance (Student Use)	Desktops	4
H205 Lab	Desktops	30
Library	Desktops	37
Yearbook Room	Desktops	5
Misc Classrooms (SPED)	Desktops	4
Total number of desktops assigned to faculty and administrators:		**23**
Total number of desktops available for student use:		**217**
Total number of desktops unassigned - used as replacement machines throughout the District:		**2**

BHS Computer Labs and Stations Additional Software: In addition to all of the above software, certain labs have additional software added. (See spreadsheet for complete listing.)

- General lab: E.g., Finale Notepad 2008, Logger Lite and LabQuest, Logger Pro 3.8.4, Nutritional Software Library
- Library: E.g., iTALC
- Business lab and computer science lab: Automated Accounting 8,0, Command Prompt, FFr-Keymap, Finale NotePad2002, IrfranView
- Drafting and technology lab: Cadsoft Envisioneer Construction Suite 5, Autodesk Design Review 2009, Turbo Floor Plan Home Designer, 7500 Home Plans, Lego MindStorm NXT 2.1, CREO 2.0, 3D Cube
- Music lab: Finale Notepad 2006, 2008, HomeStudio 2004, Mixercraft 5, Teaching with Reason 3.4.0, Synchroneyes 7.0
- Art lab: EMC Retrospect Express HD, SanDisk Transfer Mate, ABBYY Finereader 6.0 Sprint, Honestech Claymation Studio 2.0, Adobe CS3, After Effect
- Foreign Language lab: Sony Soloist 7.4.5, Grammar Word Tutor (Fr and Sp)
- Science teachers work station: Bluetooth for Smarth Slate Tablet, Boardworks, ClocX, ExamView Pro, Logger Pro, TestBuildere, LabQuest
- Math teachers work station: Exam View Generator, HS Activity Generator, LaxTXT, Mathtype6.9, McDougalLittle Test Generator, SmartNotebook with Math Tools, Texworks
- Guidance Counselors Work Station: Naviance ducofide virtual printer
- SPED administrators work station: WIAT-III Scoring, BASC-II, WISC-IV, PsychCorpCenter, Conners 3
- Administrators: KVS, CS3 Master Suite, Office 2007
- Computer Dept: Citrix XenCenter, FileMaker Pro 5, KVS, PCAnywhere, Symatec Ghost

Desktop Student Usage

The general lab, library computers and foreign language lab are always fully scheduled and are consistently used for research, work creation (student presentations, videos, etc.) and subject-specific programs. The subject-specific labs are course-connected, and so certain courses like Piano or graphic art depend entirely upon the lab technology.

LAPTOPS: Laptop carts are used in **English and Social Studies** classrooms for research, for extended writing exercises, and for work production (Powerpoints, Videos, etc), and in **Science classes**, for experiments and data analysis conjunction with various probes (e.g., for measuring temperature, force, motion, etc.), for experiments. Some examples of subject-specific laptop software in science includes: ActivePad, Dashboard, Interactive Physics 5, LabQuest Emulator, Logger Pro, Motic Images Plus, Lego Mindstorm NXT. Other departments use LT's as well.

High School	Laptops	Total Number: 201
Faculty/Admin Laptops	Laptops	101
Laptop Carts (2)	Laptops	48
Science Laptops (4)	Laptops	48
Replacement Machines (District)	Laptops	4
Total number of laptops assigned to faculty and administrators:		**101**
Total number of laptops available for student use:		**96**
Total number of laptops unassigned - used as replacement machines throughout the District:		**4**

THE BHS ONE-TO-ONE IPAD PROGRAM

All students and teachers at BHS have an iPad. iPads are leased and are provided with a breakage-resistant case and the applications listed below. All teachers are expected to incorporate iPads in at least one of four ways:

- to create and/or communicate content;
- for higher order thinking;
- for checking for understanding in interactive ways;
- and for collaboration.

iPad App Name	Price
Adobe Illustrator Draw	0
Adobe Photoshop Express	0
Adobe Spark Page	0
Adobe Spark Video	0
Amazon Kindle	0
Animoto Video Slideshow Maker	0
AP Environmental Science	0
AP Exam Prep Environmental Science	0

audioBoom	0
Best Buddies Mobile	0
Book Creator for iPad	4.99
Bookshelf	0
Breathe2Relax	0
Brushes Redux	0
Calculator Pro+ for iPad	0
Canva - Photo Editor & Design	0
Capti Voice	0
ChatterPix	0
Classroom	0
Cubelets Blockly	0
Decibel X: dB, dBA Noise Meter	0
Desmos Graphing Calculator	0
Djembe! Free	0
Dragon Dictation	0
DrawCast	0
DRC INSIGHT	0
Dropbox	0
EarthViewer	0
EasyBib	0
eClicker Audience 2	0
eClicker Presenter 2	2.49
Edmodo : Classroom Tools	0
Educreations	0

EMD PTE	0
EV3 Programmer	0
Evernote	0
Explain Everything™ Classic	4.99
FirstClass Mobile	0
Flashcards*	0
Flipgrid.	0
Fooducate Healthy Diet Coach	0
GarageBand	0
GeoGebra Classic	0
Gmail - Email by Google	0
GoodReader for Good	0
Google Chrome	0
Google Classroom	0
Google Docs	0
Google Drive	0
Google Earth	0
Google Keep	0
Google Sheets	0
Google Slides	0
Google Translate	0
Graph Literacy	0
Green Screen by Do Ink	1.49
H&R Block Budget Challenge	0
Hands-On Equations	0

HE.NET Network Tools	0
Hudl	0
Hudl Technique	0
Hyperlapse from Instagram	0
Image Reflector	0
iMovie	0
Inspiration Maps™	0
iSpeech - Text to Speech	0
iTunes U	0
IXL - Math and English	0
Kahoot! - Play Learning Games	0
Keynote	0
Khan Academy	0
KOMA KOMA	0
Learning Ally Link	0
LFO To Go	0
Lingt	0
Metronome	0
Middlesex Community College MA	0
MotiConnect	0
Music Tutor (Sight-reading)	0
myHomework Student Planner	0
MyScript Memo	0
NASA	0
Nearpod	0

Newsela	0
NOOK	0
Notability	0
Nuclear	0
Numbers	0
OCR Scanner with LEADTOOLS SDK	0
Onshape	0

Virtually all students use their iPads as note-taking (**Notability, e.g**.) and assignment planning tools. During lectures and discussions, students use them in class to research information either prompted by the teacher or by their own interest. Students use them for recording pictures, interviews and experiments, and for most English classes, where student reflections have become the norm, they capture their work products, store them and reflect upon them. They use them as analytic tools (spreadsheets).

They are regularly used by teachers to check for understanding **(Socrative, e.g.,)** as students record their answers to projected questions and the classes' responses are graphed on the SmartBoard and analyzed in real time. The seminal instructional research by John Hattie (from 900+ meta-analyses, clearly indicates that feedback has the greatest effect-size of all teaching strategies. iPads make possible a previously implausible degree of ongoing assessment of student understanding that not only fully informs the teacher as to who actually understands and who does not, but it also ensures that all students answer the question and therefore must think about it. In this way, the iPad-facilitated questioning and answering is not only an assessment process, but also an engagement and learning process. Graphing the whole class's responses and involving the students in an exploration of their responses further deepens the learning.

Students access, complete and submit work and receive feedback via **Evernote, Google Drive and Dropbox**. With significant numbers of teachers having moved to paperless communication, the students also use their iPads to access and complete assignments (from teacher web pages) and send them to their teachers. Students also use their iPads to access teacher-created videos, content and direction from teacher web pages like the one below.

https://sites.google.com/a/bedford.k12.ma.us/morrison/home

A number of teachers have "**flipped the classroom**" or engaged in other forms of lecture recording or the creation of how-to videos that students then view at home. **Students also create how-to videos** that not only assist their peers but clearly demonstrate a deeper understanding of the subject matter.

IPADS, COST OR TIME-SAVING EFFICIENCIES AND IMPROVED LEARNING

Several math classes are using **i4Class,** a web-based program that challenges students to keep working at problem sets until they get them right; provides video tutorials for each new concept; self-corrects and enables the teachers to track the students' progress. This yields several dividends:

- Students working at home persist at trying to solve their problem sets
- The teacher saves time previously spent on correcting homework and has more time to help students in class
- Teachers do not have to use the first part of the class meeting to review the homework, but rather, he/she begins the class knowing which areas the students found most difficult and can tailor the lesson accordingly.

Research, writing and collaboration using **Google Docs** and other programs are common student uses of the iPads, particularly since we purchased keyboards to make extended writing more accessible. **Desmos.com** is a free interactive graphing calculator that works seamlessly on the iPad and has been adopted in many math classrooms. It has several interactive features that make graphs come alive. **Schoology** and **Google Classroom** are top choices of many teachers at the moment for sharing digital content with students.

PCs and Laptops Freed-up By iPads.

The iPad one to one initiative has enabled us to take one high school computer lab off line and turn it into a classroom. Since they were Wyse Terminals they cannot, unfortunately be used in other schools. The iPad initiative has also enabled us to move 48 laptops to the middle school. (For fuller explanation, please see MemorandumiPads in Appendices)

TEXTBOOK REPLACEMENT

This has gone more slowly than originally assumed largely because the textbook companies have moved quickly to make online versions relatively expensive. However, teachers are creating their own content and to date, Biology, Chemistry and AP Environmental Science have moved to electronic textbooks and will not be buying any hard copies of their textbooks. (For fuller explanation, please see MemorandumiPads in Appendices)

The program also airs student video work. This equipment is listed in the appendix.

JOHN GLENN MIDDLE SCHOOL

DESKTOP DISTRIBUTION AT JGMS

JGMS (Facilities and CO)	Desktops	Total Number: 124
B124	Desktops	4
B125 (Skill Center)	Desktops	6
B216 (Computer Lab)	Desktops	30
Central Office	Desktops	8
D204	Desktops	3
Facilities	Desktops	2
Library	Desktops	26
Main Office/Custodial/Cafe	Desktops	5
Student machines in classrooms	Desktops	40
Total number of desktops assigned to faculty and administrators:		**13**
Total number of desktops available for student use:		**111**

Special Education (at JGMS and BHS): Certain departments (students and teachers) use technology in very specific, fully integrative ways. Special education teacher and students usage provides a powerful case in point. Some of these applications are PC based and some are iPad based.

- **Communication** with students via email, Google Classroom, Schoology - *teachers report that this has dramatically increased student engagement* and with **students and parents** via websites, message blast - *helps to increase student accountability*
- Apps that *promote student learning* for students with disabilities: **breathing and meditation apps** for our students with *social/emotional disabilities,* **IXL** for students with *math challenges;* **DragonSpeak** for students with *written expression struggles*
- *Supporting student organizational difficulties* with note-taking apps (**Notability, Evernote)** and online daily planners
- **AIMSweb** at JGMS for **progress monitoring and data tracking**- *provides informal assessment information*
- *Engaging students in the learning process* through various tools for demonstrating knowledge and understanding- **iMovie, Prezi**, etc.
- Creating digital portfolios for learning with **Google Sites**
- *Supporting group learning* through common apps such as **Google docs**
- *In-the-moment information to parents in meetings* via use of iPads and laptops- being able to access **Aspen for IEPs, schedules, grades** in meetings helps support communication with parents
- **Kurzweil** program to support our *struggling readers* (text to voice)
- *Behavorial data collection* apps on the **iPads**

- General Lab and Library Lab: E.g., Photoshop Elements, Mapmakers Toolkit, Scopemaster
- Library- iTALC
- Special Ed Teachers Work Station: WIAT-III/IV Scoring, BASC-II, WISC-IV, PsychoCorpCenter, Connors 3
- Math Teachers Work Station: Easy Planner Math: Algebra1, Algebra2 & Geometry
- FL Teachers Work Station: EuroTalk French, EuroTalk Spanish

Self-paced learning reinforcement. Middle School teachers have been using a program called iXL for supplemental practice. iXL is a web based program that essentially provides additional practice in targeted math areas and, for grammar, in English Language Arts. It is widely used in the Skills Center.

Usage

The labs and library are fully scheduled and are used for research, extended writing assignments, work product creation and presentation, and subject-specific programs.

Laptops at JGMS are used by administrators and faculty, and laptop carts are used in classrooms for research, extended writing, work production and collaboration.

JGMS (Facilities and CO)	Laptops	Total Number:206
Central Office	Laptops	4
Design Lab (Library Lab)	Laptops	28
Facilities	Laptops	3
Faculty/Admin Laptops	Laptops	66
Laptop Carts (3 Carts)	Laptops	75
Tech Ed (2 carts)	Laptops	30
Total number of laptops assigned to faculty and administrators:		**73**
Total number of laptops available for student use:		**133**

iPads and Chromebooks at JGMS

The usage has grown steadily since these devices were first introduced with usage relatively evenly spread across the core subjects. Easier to use than laptops, which require set-up time, the iPads and Chromebooks are increasingly the technology of choice. JGMS currently has 10 carts each with 30 iPads and 2 carts each with 30 Chromebooks for use in the classrooms.

Similar to the high school, iPads and Chromebooks are used in class for research, just-in-time assessment, project creation and knowledge demonstration (iMovies, story boards, power points, etc.). In science classes, they have been used for live interactive learning through such programs as **EarthKam,** created by astronaut Sallie Ride, where students compete with learning projects that involve interaction with the space station and its imaging equipment.

Apps and Potential for Bringing Own Devices. JGMS iPads have many of the same applications as the BHS iPads. We are not one-to-one at JGMS and do not plan to be until, perhaps, we reach the stage when bringing one's own device will make sense in terms of assured access, ubiquitous apps., network safety and device affordability.

LANE SCHOOL

DESKTOP DISTRIBUTION AT LANE

Lane	Desktops	Total Number: 95
Computer Lab (Multipurpose Room)	Desktops	28
Library	Desktops	5
Lower West Wing	Desktops	8
Upper West Wing	Desktops	9
Student machines in classrooms	Desktops	40
Main Office/Cafe/Custodial	Desktops	5
Total number of desktops assigned to faculty and administrators:		**5**

Total number of desktops available for student use:	**90**

Lane School Computer Lab and Library Program Sample Uses:

- Science and Technology: Lego WeDo, Mapmaker's Toolkit- All 3rd and 4th graders learn about programming and how to think critically through the building of mechanical creatures and Ferris Wheels using Lego Robotics. After they build them, working in pairs they figure out how to program them to achieve the desired result.
- 5th graders will work with a variety of tools, such as MIT- generated Scratch software, to learn programming basics.
- Programming Tools: "The Lego education tools provide a learning solution that blends hands-on manipulatives with integrated technology and curriculum to create a minds-on experience that is aligned with key educational standards and learning objectives. The project-based activities help build science, technology, engineering, and math (STEM) knowledge while incorporating lessons in language arts. Students will utilize their skills to create moving models, all while enhancing their creative and problem-solving abilities."
  https://education.lego.com/en-us/lesi

  Students at Lane also learn programming skills through the use of different programs/tools, i.e., Code.org lessons, the use of Sphero and Meccano robots and creation within MinecraftEDU.

Lane	Laptops	Total Number: 24
Faculty/Admin Laptops	Laptops	58
Library (Purple Cart)	Laptops	12
Navy Cart	Laptops	26
Total number of laptops assigned to faculty and administrators:		**6**
Total number of laptops available for student use:		**18**

Lane Software
Computer lab desktops contain the Base Template plus Lego WeDo and Mapmaker's Toolkit. Teacher stations include additional software such as Diorama Designer, Factory Deluxe, Rainforest Designer, Tessellation, Work and Simple Machines, Time Liner 5, etc.

Laptops at Lane are used by administrators and faculty and by students within their Library program. A laptop cart is also available for use in classrooms for research, extended writing, work production and collaboration.

iPads and Chromebooks at Lane School
The iPads and Chromebooks at Lane have been used in outstanding ways. Lane currently has 6 carts each with 30 iPads and 2 carts each with 30 Chromebooks for use in the classrooms. In

addition, approximately a dozen iPads obtained through grants and other funds have been used by special education teachers to augment instruction in small groups.

The 30 iPads that were leased in the FY15 operating budget were used in two classroom pilots. One of these, the **fifth grade digital portfolio project**, along with its counterparts in the high school English and Foreign Language departments, exemplified deep metacognitive learning. Students recorded, took pictures of, or otherwise saved their work on a regular basis. Part of their learning involved curating and critiquing their own work, selecting what they considered to be a strong example and provided a rationale. By reviewing the progress of their skill development, for example by examining a series of writing assignments over time, with perhaps a teacher determined focus such as voice, or character development, or logical organization, the students not only improved the relevant skills but became aware of the relationship between work and progress, or mistakes and improvement. This pilot has encouraged other grade 5 colleagues to promote the curation of student work and reflection of learning through the use of student digital portfolios.

This is a direction that we intend the whole district to move in over the next several years as we train teachers to guide their students through portfolio creation and reflection, and as we develop the technological capacity to warehouse large amounts of student work. Our **core goal of developing reflective, independent learners** depends upon the development of students' **metacognitive skills**, which in turn depends upon their **learning how to select, categorize and critique their own work over time**.

Similarly, our **ability to assess students' higher order thinking and their ability to use, apply or transfer their skills and knowledge** depends upon the creation of what we call **performance-based and project-based assessments.** These too will become a part of the students' cumulative portfolio of work. iPads and Chromebooks (or similar handheld devices) are essential to the process of recording this work and storing it in a digital, perhaps cloud-based, platform. They also provide a versatile means of accessing this work by students and teachers.

DAVIS SCHOOL

DESKTOP DISTRIBUTION AT DAVIS

Davis	Desktops	Total Number: 73
Blue Pod	Desktops	12
Green Pod	Desktops	12
Library Lab	Desktops	25
Red Pod	Desktops	12
Yellow Pod	Desktops	12
Main Office/Custodial/Cafe	Desktops	5
Total number of desktops assigned to faculty and administrators:		**5**

Total number of desktops available for student use:	79

Davis Desktop Usage
In the library computer lab, students regularly learn about communities and geography using **Google Earth** and about basic societal functions such as resource gathering, maintaining health and building useable structures through **MinecraftEDU**. They have also been introduced to coding through the Hour of Code.

The desktops in the pods had long been unusable, as Davis was the bottom of a trickle down computer distribution approach that could not keep up with demand. Our multi-year technology plan seeks to redress this deficiency so that instructional technology can be shared by multiple classrooms on a regular basis.

iPods, iPads, Chromebooks and Differentiated Instruction
iPods and iPads are used as listening devices in small group reading centers (the Daily Five) where students move from center to center to access literacy through different kinds of learning activities, one of which is listening to stories. Teachers are further integrating the iPads and Chromebooks into individual and small group reading and math instruction, as they provide a plethora of self-paced learning opportunities to students. In this way, they make possible a level of differentiated instruction (tailored to students' learning styles or learning needs) that would not be possible without these devices.

Additionally, they are used to capture students' thinking and learning, where students use visually and/or orally record their work and then present it. The iPads and Chromebooks are used as well for elementary research. Davis currently has 5 carts each with 30 iPads and 2 carts each with 30 Chromebooks for use in the classrooms.

Davis	Laptops	Total Number: 7
Faculty/Admin Laptops	Laptops	49
Orange Cart	Laptops	12
Total number of laptops assigned to faculty and administrators:		**49**
Total number of laptops available for student use:		**12**

SMART Table: Davis has one grant-funded (Bedford Education Foundation) SMART Table, which is a highly interactive, tactile whiteboard laid horizontally that enable small groups of students to work together manipulating data and solving problems. "The SMART Table is a multi-touch and multi-user interactive learning center that allows groups of students to work simultaneously on its surface. It engages students through audio, visual and tactile activities, thus providing an inclusive learning environment that fosters collaboration and creative problem solving." * SMART Tables are a newer technology; we are basing the life span of these devices on the industry standard of the life span of the SMARTBoard.
http://education.smarttech.com/en/products/smart-table

APPENDICES

A. EXCELLENT EXAMPLES OF STUDENT LEARNING

Please visit our Biblio-TECH Newsletter at http://bedfordtechlibrary.weebly.com/

B. HARDWARE LIFESPAN

Technology	Cost Per Unit	Life Span
Epson Brightlinks	$ 5,000	7 years
Chromebooks (incl. mgmt. lic.)	$ 300	3 years
iPads Year 1 of 3 year lease (incl. case & mgmt. lic.)	$ 350	3 years
Laser Printers	$ 1,200	7 years
PC Desktops	$ 800	5 years
PC Laptops	$ 1,150	3 years
SMARTBoards	$ 5,000	7 years
SMART Table	$ 8,500	7 years
Programming Tools	$ 1,500 - $14,000	5 years

C. BHS TELEVISION STUDIO EQUIPMENT

Live Platform Area: (This is the area of the studio where they broadcast BHS Live.)

- 3 cameras
  - 3 JVC 3-CCD Pro Camcorder with 16:1 Fuijinon Lens
- 3 camera stands
  - 3 Manfrotto Tripods Camera Stands
- 1 microphone
  - 1 Shure SM48 Microphone
- 1 microphone stand
  - 1 Shure Microphone Stand
- 1 microphone cable
  - 1 - 25ft XLR Microphone Cable

TV Studio Recording Area: (This is the area of the studio where they record and monitor the broadcast to make adjustments to audio levels and run the broadcast of BHS Live.)

- 1 recording station
  - 1 DVD recorder/player/disk drive
    - 1 - JVC SR-DVM600 (3 in 1 Video Recorder/Player MidiDV, DVD, Hard Disk Drive)
  - 1 DVD/VHS video recorder combo

        - 1 - JVC SR-MV45 (DVD Video Recorder/S-VHS Video Recorder Combo Deck)
    - 1 DVD recorder
        - 1 - DVD Panasonic DMR-EZ28 (DVD Recorder)
- 1 digital video mixer
    - 1 - Mackie 1402-VLZ3 Mixer (Studio Monitoring, Digital recording, Amplifer mic/line channel with fader)
- 1 two channel communication device
    - 1 - Anchor Audio BP-200 with Headset/Mic (Portable two channel communication device)
- 1 digital audio mixer
    - 1 - Panasonic AG-MX70 Switcher (8-Input Professional Digital A/V Mixer)
- 1 - 10" monitor to preview camera/DVD input
    - 1 - JVC TM-A130SU 10" monitor
- 4 – 10" monitor to preview camera/DVD input
    - 4 - JVC TMA1-1GU 10" monitor
- 1 computer and 17" monitor with media broadcast connections to add text to video in real time and convert the signal to the appropriate format

D. iPads at BHS- impact on desktops, textbooks, etc.

MEMORANDUM

TO: CAPEX
FROM: Jon Sills
RE: iPads
DATE: October 31, 2017

This memo responds to CapEx question regarding the degree to which the one-to-one iPad program at BHS has led to fewer textbooks being purchased, less paper and printing being done, and fewer laptops and desktops being needed.

DATA

Desktops and Laptops. The one-to-one iPad program has reduced the number of desktops and laptops at the high school. Five laptop carts were moved from the high school to other buildings 72 computers) and not replaced. One large computer lab was converted to a classroom, eliminating 33 desktop computers. Finally, classroom based desktops were reduced by about 35 computers, leading to a total of approximately 135-140 fewer laptops and desktops at the high school.

The majority of computers at the high school serve specialty functions requiring much more firepower than iPads contain. These include the graphics capabilities in the Art Lab; the teacher-controlled interactive voice and recording capacity of the Foreign Language Lab; the programming capacity of the Computer Science/Business Lab; the extensive synthesizer capacity of the Music Lab; and the ports for ancillary lab hardware in the Science Department laptop carts. Please see below for age and distribution of desktops and laptops at the high school.

BHS Inventory - *Based on using FY18 as 0*

Age	# of Desktops	Desktop Locations	# of Laptops	Laptop Assignments
<1 Year	30	Student machines (H205 general computer lab)	64	Teacher workstations
1 Year	60	57 student machines (9 Business Lab, 17 Art Lab, 31 Foreign Language Lab) 2 servers, 1 custodian	47	Teacher workstations
2 Years	55	55 student machines (Business Lab, STEP, Yearbook, Drafting Lab, Bridge, Skill Center, classrooms)	3	Staff (1 G. Godzyk, 1 M. Turkewitz, 1 D. Clements)
3 Years	45	36 student machines (32 Library, 4 Guidance), 2 Math/Science Office, 2 Foreign Language Office, 2 English/Social Studies Office, 3 staff (1 D. Higson, 1 N. Powell, 1 P. Carlson-Bancroft)	1	Projector cart
4 Years	5	student machines (Library)	0	
5 Years	21	student machines (Music Lab)	0	
6 Years	0		14	Science cart (Silver)
7 Years	0		62	60 student machines (24 general use carts - Lemon and Lime, 36 science carts - Red, Green, Blue), and 2 projector carts
Totals:	**216**		**191**	

Ink, Toner and Paper Both ink and toner use and numbers of pallets/cases of paper have trended downward significantly since 2012/2013.

FY	Number of Ink and Toner Cartridges Purchased
2012	617

2013	570
2014	534
2015	401
2016	222
2017	240

Textbooks. Virtually all classes supplement textbooks with online resources. However, in terms of actual substitution of digital textbooks for hard copy textbooks, the practice is limited to the Science Department, which uses digital textbooks for all of its chemistry (200 plus) and biology (200 plus) classes. In math (Algebra I, Geometry, Algebra II) we have extended the life of 10 to 15 year old textbooks by creating supplemental digital materials.

GENERAL ASSESSMENT

Unquestionably, the iPads at the high school have yielded reduced costs across these three categories. However, the anticipated saving vis a vis digital textbooks has not materialized, except to the degree that we have significantly reduced annual replacement costs for lost or damaged textbooks. This is the case despite the available research that predicted that these savings would be significant. The reason for this is that the publishing companies, whose digital textbook inventories were virtually non-existent at the time that Bedford adopted the 1:1 program, quickly moved ahead to capitalize on the new market opportunities and have priced their digital textbooks to match the cost of hard copy textbooks over a multi-year period.

But while fiscal savings were promised to help to justify the cost, some of which have materialized and others of which have certainly not, they were not the impetus for moving to a 1:1 environment at the high school. The primary drive was to transform instruction by providing tools that would lead to more student centered and independent learning. According to our technology director, and substantiated by my own observations, "Many teachers have digitized their content, added multimodal elements, and shared it with students through various digital tools, including classroom websites, Google Classroom, IXL, YouTube, and Google Drive. In lieu of paper handouts, many teachers have digitized content and electronically shared information with their students who have the ability to access teacher-created and web-based content on their iPads both at school and at home. Students have access to information at their fingertips for "just in time" research and self-paced learning. They utilize digital apps and tools to collaborate with peers, annotate documents, complete assignments, create multimedia content to communicate and demonstrate understanding, receive feedback from teachers, curate and reflect on their learning, etc. Digital tools empower students through differentiated learning by allowing them to access and create content through various modalities. The integration of the iPad camera with apps, for example, simplifies the complexity of video production. Teachers create multimodal assessments to check for understanding and adjust their practice to better meet the needs of their students. The iPad can both engage students and personalize their learning.

As well, we have embraced the idea of digital text for students and currently have subscriptions to several databases with updated content, and web-based libraries, such as OverDrive, for students and teachers to access eBooks, audiobooks, and videos. Subscriptions can be quite costly, but we have been able to sustain the cost through our library operating budget by reducing the number of hard copy resources we purchase."