SACRAMENTO CITY UNIFIED SCHOOL DISTRICT
BOARD OF EDUCATION

Agenda Item# 9.1

Meeting Date: **November 17, 2011**

Subject: **Technology Update**: Preparing the District's Technology Environment to Support 21st Century Learners

- ☒ Information Item Only
- ☐ Approval on Consent Agenda
- ☐ Conference (for discussion only)
- ☐ Conference/First Reading (Action Anticipated:_____)
- ☐ Conference/Action
- ☐ Action
- ☐ Public Hearing

Division: Accountability Office

Recommendation: None

Background/Rationale: The Assistant Superintendent, Information Education Technology will update the Board of Trustees on the current technology environment at SCUSD. There will be an examination of the current limitations and insufficient technology infrastructure that prevents the District from providing a stable and equitable technology environment.

Financial Considerations: Phase I technology implementation, recommended by the Assistant Superintendent, Information Education Technology, will leverage the District's recently allocated Bond Modernization Funds to deliver a secure and stable infrastructure for District technology services.

Documents Attached:

AMS.Net Network Assessment and Recommendations
Challenge Based Learning Study
Chicago Public Schools IPad Project Study
Apple Professional Development Overview

Estimated Time of Presentation: 30 minutes
Submitted by: Terry Kritsepis, Assistant Superintendent, Information Education Technology
Approved by: Mary Shelton, Chief Accountability Office

Board of Education Executive Summary

Technology Services
November 17, 2011

I. Overview/History of Department or Program

The SCUSD Technology Services Department is guided by the vision of providing students, staff, and the community with information technology resources and services that support learning, instruction, research, professional development, data collection, and administrative operations. Ultimately, the role of the department is to support the technology environment in teaching and learning as outlined in the District Strategic Plan 2010-2014: Putting Children First.

II. Background:

Strategic Plan 2010 – 2014: Putting Children First represents Sacramento City Unified School District's ongoing effort to improve the education we provide to every student in every classroom so they can meet the challenges of our 21st Century world.

Our challenge is that the District technology environment is insufficient to support and sustain the current technology needs of a 21st Century Learning Community. It is also not designed for future growth in new and innovative technologies that are available to the modern classroom.

In reviewing the District's Technology Plan, initiatives to develop a modern and sufficient infrastructure to support 21st Century teaching and learning have fallen short or were lacking the vision to accomplish this desired result. Also, in convening a District Advisory Group consisting of tech staff, principals, teachers and parents, the overwhelming consensus is that a new vision and the implementation of a stable and robust infrastructure that supports District technology is of the outmost importance.

Our role as Technology Services is to support teaching and learning as outlined in the District Strategic Plan. In support of our learning community, today and tomorrow, we are faced with no other option than to rapidly correct the deficiencies in our technology environment. We will utilize education technology industry best practices, explore 3rd party vendor relationships and responsibly allocate existing district funding to accomplish this initiative.

To fully understand the district's technology performance challenges, a Technology Infrastructure Assessment was performed by AMS.NET for the Sacramento City Unified School District during the months of June and July of 2011 (see attachment). The assessment was inclusive of the infrastructure that serves the students, faculty and administrative staff of the Sacramento City Unified School District.

The guiding principles used for assessing the district's technology environment and in designing solutions were focused on the following desired results:

- **Streaming educational content and video**
- **Increasing usage of wireless multimedia devices**
- **Extending the technology education experience to 24/7 accessibility not limited to locations and devices**
- **A robust and secure technology network built for today's educational needs with capability to absorb new advancements**

Network Assessment Findings:

- Significant latency and performance limitations to the SCUSD Wide Area Network
- Technology environment that is susceptible to security breaches and threats
- Poorly designed network that limits access for teachers and students

- Limited network ability to accommodate technology such as Voice over IP, video capabilities and the increased use of mobile devices

These findings will enable us to create a highly productive and efficient technology infrastructure that supports the District's Strategic Plan in preparing College Ready Students, Family and Community Engagement and Organizational Transformation.

III. Budget:

Phase I technology implementation, outlined in the Major Initiatives section, will leverage the District's recently allocated Bond Modernization Funds of approximately $2 million to deliver a secure and stable infrastructure for centralized District technology services.

IV. Opportunities:

Building a digital learning environment does not happen without vision and leadership. Whether it is bottom up or top down, everyone on the leadership team needs to be on board with a shared vision.

Guiding questions used to develop this initiative that supports the SCUSD vision and strategic plan:

- What can we do differently today to provide opportunities for students?
- How do we support students to become knowledge creators, collaborators, inventors and innovators and to create critical and higher level thinking skills?
- How do we support students to have the greatest level of opportunity for learning in and outside of the classrooms?
- How do we support the Digital Curriculum Plan that complements Common Core standards with the Accountability and Academic Offices?

We are fortunate that two market leaders in this industry, Cisco and Apple, share in our vision and are willing to contribute and invest in our success.

Both are single source partners that will provide integrated end-to-end solutions. Both provide a leveraged cost model with a single point of contact for implementation and support.

Their contributions and domain expertise in our technology partnership benefits the District's limited resources, time and staffing to support and sustain the current technology needs of a 21st Century Learning Community.

In working with the District's existing resources, Cisco and Apple look to deliver a showcase technology infrastructure that will result in a 21st Century classroom.

It is proposed that this unique and innovative initiative partnering our school district and these two market leaders, be delivered in a two-phased model.

V. Major Initiatives:

Phase I

Infrastructure and Education Technology Model

The first deliverable, utilizing the District's Bond Modernization Funds, is to implement a secure and stable Cisco designed infrastructure for centralized District technology services.

The new infrastructure includes the following:

- Unified Communications Systems addressing chasm between District Office and school sites. One common platform for voice, video and instant messaging communications
- Network Refresh to provide a secure and stable wired and wireless infrastructure
- Video library that will enable professional development and collaboration for both teachers and students. Tools that will allow users to record, edit, view and share video content anytime, anywhere on any device

Implementing a Cisco designed infrastructure will enable the 21st Century Classroom. Rosa Parks Middle School and California Middle School will be the Phase I implementation sites.

21st century classroom:

It is important to create a digital learning environment that equips teachers and students with the tools that are required to meet the needs of the modern and global society. This new wave of digital native students with a reliance on technology is transforming our world and is forcing teachers and administrators to rethink their approach towards traditional teaching and learning.

Apple will work with teachers and students at Rosa Parks Middle School and California Middle School to create and implement a Challenge Based Learning Environment (see attachment).

Challenge based learning will provide our students a technology based platform for individualized, engaging and differentiated instruction. It will allow students to use technology in projects that incorporate rigor and relevance resulting in critical thinking skills in problem solving. This approach aligns with the District Strategic Plan in preparing students for college and beyond.

Professional development is a critical success factor in supporting teachers at school sites. Specifically, for Rosa Parks and California Middle Schools professional development plans will be outlined with the Principals that encompass a multi phased approach:

- Site Discovery process - How does the use of the technology fit into the Strategic Plan, School Site Plans, and what outcomes are expected?
- Site capacity building - On site workshops to cover technology basics so professional development investment is leveraged
- Professional development - The scheduling process and agenda process that aligns with the District's strategic focus on Literacy
- Coaching and Mentoring - Follow up to professional development training to ensure practices are being implemented, and there is support for the change management process.

Phase II

In Phase II, the infrastructure technology plan will be rolled out to the remaining school sites across the district. Timelines will be dependent and developed upon federal technology funding as well as available District Technology Funds.

Future classroom implementations will also depend upon the results of Phase I, funding and student achievement outcomes.

VI. Results and Next Steps:

- Build a high performing Wide Area Network at the District Office and Phase I model school sites
- Create a sustainable and secure technology environment, protecting student and district information
- Develop seamless access for teachers and students using mobile devices
- Build a reliable infrastructure that can support 21st Century content and solutions
- Assess student outcomes at the two schools using Apple technology and challenge based learning in curriculum.

Sacramento City Unified School District

Network Assessment and Recommendations

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Executive Summary

AMS.NET is extremely pleased to present this assessment and recommendations for your evaluation and consideration.

Today, IT organizations are being pushed and pulled in many directions. Evolving business models create complex technology challenges that IT is being asked to solve. IT consumerization is empowering students, faculty and parents, which in turn introduces new devices and risks that IT must manage and balance. Many of the new applications and solutions involve video which puts more demand on IT and the networks they support. Organizations, such as Sacramento City Unified School District, must evolve to adapt to the new workplace and educational environment.

- **Increasing usage of multimedia devices:** The new generation of students, faculty, administration, and parents bring highly mobile video devices into the educational environment. These devices bring an expectation of leveraging the video and audio experience they bring. Thus, IT must deal not only with new devices and usage models, but also with changing administration practices that place huge new demands on the infrastructure.
- **Extending the educational experience:** In today's classroom, it is increasingly common that primary educational resources, including data centers, applications, students, and teachers, may be outside the traditional school or district perimeter. IT needs a new way to scale and manage students and teachers in any location. These users may be using virtually any device to access almost any application located anywhere in the geography.
- **Removing location and device borders:** With new Wi-Fi devices connecting to the network, there is a dramatic shift occurring towards pervasive wired and wireless access. This will change how we design, deliver, and manage the access edge of the network.
- **Enabling secure access anywhere with any device:** In the past, data, applications, and users were housed on premises. Today, students and teachers can extend the educational experience literally across the globe. IT must ensure the security and safety of its students and employees while enabling this rich experience.

How we got here:

A Network Assessment was performed by AMS.NET for Sacramento City Unified School District during the months of June and July of 2011. The assessment started as an initial overview of the network that serves the students, faculty and administrative staff of the Sacramento City Unified School District. The main purpose for the assessment was to look for a root cause for an application timeout problem as well as general network performance issues. The observations made during this process also provided insight into the overall state of the network in general and these will be addressed in terms of industry 'best practices' and recommendations.

The Zangle issue, or the original root cause we came out to assess, was happening almost every day while school was in session at Hiram W. Johnson High School (HWJHS) campus. Long pauses or delays within the application were the result of the Zangle issue. At times, this would lead to a lockup of the program. In addition to the findings of the Zangle issue, general performance problems have been reported such as network slowness and other connectivity problems.

After further review, we started to take a look at the WAN core and other LAN's within the district. The intent was to not only help solve the specific Zangle server issue, but to also determine where the district was at from an infrastructure perspective. We also discussed Wireless connectivity when we first were going through some of our initial findings and how this would benefit the district.

Methodology:

The methodology used for this network evaluation consisted of the following:

- A high level walkthrough of the network and discussions surrounding the connectivity of the Local Area Networks (LAN) at not only Hiram W. Johnson High School but a sampling for additional school sites as well. AMS.NET also assessed the Wide Area Network (WAN) interconnectivity of the sites to the District Office.
- Observation and review of sample configurations, focusing on the H.W. Johnson HS Campus and District Office core equipment. It was also discovered that the configuration at HWJHS was consistent with the other sites AMS.NET assessed.
- Packet capturing and analysis of live network traffic on the District's WAN and LAN(s).

The problem originally reported did not seem to effect all other sites in the same manner, therefore the initial focus does not include a detailed analysis of the WAN core or the data center servers at the District Office. Additionally, the focus of this investigation will not be on the application level itself. It should be noted, however, that these areas should not be completely ruled-out if initial remediation steps do not prove to be successful.

With that being said, later on in this document we will be describing a new advanced architecture that will not only fix the current issues that the Sacramento City Unified School District is experiencing from a network technology perspective, but that will also show a strategic vision on how to realize the latest and greatest in technology. In turn, this will allow a better learning experience now as this approach takes into account future expansion without "forklift" type upgrades that may be looked at in the near future. This advanced architecture will allow the 21st classroom learning experience to be enhanced as technology advances.

Observations:

The Wide Area Network is connected in a 'star topology' with single, point-to-point connections to the remote schools and offices. These connections are provided typically via fiber-optic transport or in some cases over traditional serial lines. Fiber optic connections are either OPTEMAN circuits, or direct 'dark fiber' runs. The OPTEMAN connection speeds are regulated by the committed information of the carrier, while the direct fiber speed is only regulated by the speed of the optical transceivers provided for the particular link. In general, these links are either 100 Megabit or 1 Gigabit. Routing between sites is provided by the industry standard OSPF routing protocol. There were no observed network layer 3 redundancies on the WAN topology.

At the Hiram Johnson H.S. campus, the focus on the network was primarily to view traffic patterns related to admin staff access to the Zangle program. Additionally, general traffic patterns were observed as part of the overall analysis. Packet traces were done on two separate days, for several hours at a time. In order to allow for easier handling of the packet capture files, the capture process was stopped and restarted at regular intervals.

The packet traces provided some very useful insight into the network and its overall characteristics. Unfortunately, during the hours of packet capturing, the admin users did not experience full program "lockup" but there were delays in processing that were observed. The packets related to these delays show the symptom but do not point to a "root cause". This type of problem, being sporadic in nature and varying in severity, can be caused by several things; heavy utilization on the LAN, heavy usage on the WAN, congestion on the WAN (on a carrier circuit that utilizes switching with shared access, like OPTEMAN), packet errors on the LAN and/or WAN, congestion on the server's network interface, and high processor utilization on the client or server. Other causes would include layer 2 spanning tree loops and layer 3 routing problems.

The following observations have been noted as either potential causes of the application delays and general network performance issues, deviations from network 'best practices' or industry recommendations.

1) Layer 1 (Physical Layer) observations:

- Interface errors on the WAN links between the District Office and the Hiram Johnson HS campus were not present. As noted previously, the common interfaces on the network and the interfaces of the servers were not included in this investigation, as other sites are not experiencing the same issue.

- WAN port utilization was not significantly high during the investigation period, and IT staff had not observed high utilization. Currently the connection to the remote campus is set to 100 megabits/sec. Staff reported that increasing the link to 1 gigabit/sec actually seemed to increase the frequency of the application delays. While the link can certainly support up to its rated speed, the chance of packet loss increases as the link nears its rated capacity. As reported and observed, this does not appear to be an issue.

2) Layer 2/Layer 3 (Data-Link and Network Layer) observations:

- No spanning-tree loops or excessive updates were observed on the LAN at HJHS. Frequent updates would indicate possible loops or overutilization of CPU on LAN switches. Likewise, there was no frequent routing table updates observed, indicating a WAN link issue. The end effect of any of these could lead to packet loss and application delay.

3) Packet capture observations:

- As noted previously, packet capturing was concentrated on a port connected to a particular admin end user that regularly uses the Zangle application. The intention was to observe this user's traffic while they were using the application and what occurred on the port if and when the application experienced any delay.

- During one of the capture sessions, the user reported a slight application delay. Once the capture file was analyzed, the delay was apparent in the data and manifested itself as TCP "retries". No other evidence was observed that would point to a root cause. TCP retries can be indicative of LAN/WAN congestion or port errors, among other things.

- One common observation that occurred was the instance of DHCP requests pointing to other addresses besides the LAN broadcast address. DHCP clients are not pre-configured to be aware of LAN subnet addressing and network masks that define the subnet. They normally send an all ones broadcast over the LAN for a response from the DHCP server in order to get this information. Some DHCP packets were observed with incorrect subnet mask and broadcast addresses. While this may or may not result in network performance issues, it is not a normal occurrence and should be further investigated.

- The most concerning observation was the existence of network unicast conversations that should not have been seen during these packet capture sessions. It should be expected that unicast conversations between devices not connected to a particular switch port should not be seen on that port. This issue may arise due to subnet over-utilization (too many devices on a single VLAN), broadcast/multicast storms, or switch hardware/software failure.

4) Additional observations:

- The entire campus at HJHS consists of a single VLAN for data connectivity. This includes student machines and staff/admin machines, both wired and wireless, as well as servers, switches, and APs. There is a separate VLAN for management of the devices, but every switch also has an IP address in the data VLAN, which makes them potentially directly accessible from any machine on the data network. AMS.NET evaluated several other school sites LAN's and found this to be a common configuration.

- With a good amount of client machines on this single VLAN at any point in time, this may lead to some of the issues mentioned above, such as broadcast storms and over-utilization. This single VLAN layout also makes the network more susceptible to security breaches such as denial-of-service attacks and password sniffing. Separate VLANs for students and admin staff, for instance, would provide a boundary where a student device would be limited to these types of security breaches only on the student VLAN. Other measures would need to be put into place to mitigate or alleviate the potential issues altogether. This will be discussed on more detail under the recommendation section below.

- Configurations on some of the switches at HJHS show some inconsistencies that should be addressed. For instance, layer 3 addresses were present on switches in their data VLAN. This serves no purpose, but does expose the switch to the data VLAN directly. It was also observed that the subnet mask on at least one of these addresses was not consistent with the rest of the network. This ultimately has led the devices connected to that switch to send broadcasts to what

looks like a broadcast address, but which is really a unicast address in the network. This did show up in the packet capturing as DHCP and other broadcast traffic from the devices on those particular switches.

- Multicast PIM “Dense Mode” is in use. This is not typically recommended on production networks. Newer multicast protocols exist that can help to keep multicast traffic more contained.

Recommendations:

Specific Long-term recommendations:

- Design and implement a multicast routing plan. Currently PIM Dense mode is configured and should not normally be used in production environments. PIM Sparse Mode with Anycast/AutoRP or SSM (Source Specific Multicasting).

- Consider an IPv6 address overlay design and implementation. IPv6 will eventually replace IPv4 and recently the IANA was depleted of all IPv4 address space.

- Invest in a traffic flow analysis (Netflow/Jflow) management platform to gain a more granular view of network traffic. Traffic flow analysis at the core and WAN connections can give a better picture of network utilization down to individual flows.

- Design and implement a Quality of Service overlay to support current and future applications. This will especially become necessary as the district moves toward newer voice and video applications.

- Secure device access via RADIUS and user network access via dot1x architecture. Manage who and when users can use your network.

- Install a guest wireless security mechanism for tracking wireless guest access. Again, control who is on your network and when they can get on.

- Implement other security mechanisms such as port security, arp inspection and DHCP snooping. This will work toward mitigation of potential network attacks, denials of services, etc.

- Invest in 10GB WAN/LAN uplinks and 1GB user ports to support newer, more demanding applications such as video.

The Vision

The next step in realizing a strategic vision and creating a highly productive and efficient IT infrastructure is to collaborate with a network and datacenter solutions expert that understands your long-term business goals and how to maximize your business’s success.

As a trusted advisor, AMS.NET can help you to build a sustainable network infrastructure that will solve more than just the current issues or needs within the District. AMS.NET will also work with you to

overcome current economic constraints so you can develop and implement an IT business plan that is primed to address future challenges and support new technologies.

AMS.NET has been promoting innovation networking solutions since 1988. Experienced in consistently and reliably delivering solid networking and datacenter products, AMS.NET delivers solutions supported by award-winning technical partners throughout the United States and world.

As a leader in technology innovation, AMS.NET is committed to fostering changes in the industry that are priorities to Sacramento City Unified School District and to supporting you every step of the way.

Where do we go from here?

AMS.NET, through the help of our technology partners, is looking to help transform Sacramento City Unified School District so that it is relevant to the needs of 21st century learners, educators, and organizations. This will require a shift in the way teachers teach, leaders lead, and students learn. Technology will play a critical role in the development of engaging curricula and meaningful assessments to equip learners with 21st century skills such as creativity, critical thinking, problem solving, and collaboration. The end goal is the systemic improvement of both the quality and accessibility of education throughout the organization.

Gain Next-Generation Learning Through an Advanced Architecture

Today, schools, colleges, and universities are under pressure to reduce budgets and meet increased expectations for educating the 21st century workforce. With a Borderless Network architecture, educators and administrators can overcome these challenges, through:

- Next-generation learning, with secure mobility services and a media-based, engaging learning environment
- Safety and security, whether physical or technological
- Administrative efficiency, with methods to increase energy savings and lower operating expenses

The Borderless Network Architecture is designed to help IT balance demanding educational challenges and changing models promoted by the influx of consumer devices into the classroom. In addition it affords you the tools to support the advanced applications and multimedia that these new experiences bring. Borderless networks help IT evolve its infrastructure to deliver seamless, secure access in a world with many new and shifting borders.

Why Borderless Networks?

- **Technology innovation:** In today's global, competitive environment, networking innovation and agility are critical success factors for all organizations. AMS.NET, through our technology partners, offers:
    - **Systems approach:** Extensible systems and integrated services combine to multiply the value of the network. Additionally, common hardware and software components and consolidated automated management enable Borderless Networks to do more with less.
    - **Complete protection:** Integrated end-to-end security services are complemented by central policies. Support systems such as Security Operations Center and processes such as Product Security Incident Response Team (PSIRT) advisories help ensure compliance.
    - **Network innovation:** Our technology partners spend over US $5 billion in annual R&D on

the network. Our partners are at the forefront of leadership in advancing network standards, service intelligence, and sustainability solutions enables operators to innovate.

- **Workplace transformation:** The new classroom experience is visual, mobile, and in the moment. For the student and teacher, the quality of the experience is everything; AMS.NET, through our technology partners, offers:

  - **Video delivery:** The end-to-end medianet solution, which is bolstered by primary services such as multicast, quality of service (QoS), and VideoStream. Validated designs, Partner IT experience, and an extensive ecosystem further heighten the positive effects of business video within Borderless Networks.
  - **Mobility solutions:** RF leadership (ClientLink technology), scalable systems (802.11n), a mobility services architecture (voice, security, and location), and wired/wireless integration (integrated services routers (ISR) and Catalyst switches) enable anywhere access.
  - **Application optimization:** Application-layer traffic controls - Wide Area Application Services (WAAS) for WAN optimization, application control, VDI acceleration.

- **Operational excellence:** Resource efficiency, IT staff productivity, systems integrity, and network readiness are all important indicators of success. offers:

  - **Advanced IOS Services**: SmartInstall, SmartAutoPorts, SmartCallHome are just a few of the hundreds of features built into our network products to help lower the operational costs while maintain a high degree of availability.
  - **Best practices:** With technical guidance (Validated Designs), IT experience, and industry solutions (K-12, Higher ED), provides customers with the tools and techniques necessary for success.
  - **Management:** Prime provides a rich set of management applications designed to configure and provision the features needed for the network services layer of the Borderless Network Architecture.
    - In addition to command and control of LAN technologies, the ***LAN Management Solution*** can be used assess, configure and deploy EnergyWise, MediaNet, SmartInstall, AutoSmartPorts, and SBA across the network.
    - ***Prime Collaboration Manager*** is valuable for monitoring and trouble-shooting Telepresence video session across the network.
    - ***Prime Network Control System*** manages the model of Unified Access for secured access to both wired and wireless devices.

  - **Lifecycle services:** AMS.NET, in conjunction with our technology partners, provides a single source, single platform, simplified solution to support voice, data, video, security, wireless and more. From the structured wiring and network infrastructure to the advanced applications that deliver video content, surveillance and other business critical services, AMS.NET has team of engineers, a cabling crew, a project management team and host of support staff to provide a turnkey implementation.

    With a single source technology provider, you have one point of contact for installation,

support and maintenance allowing for a successful implementation and support for your long-term technology plan. Utilizing a single source for structured wiring, networking, voice, security, wireless and more also provides cost containment and ultimately a lower total cost of ownership.

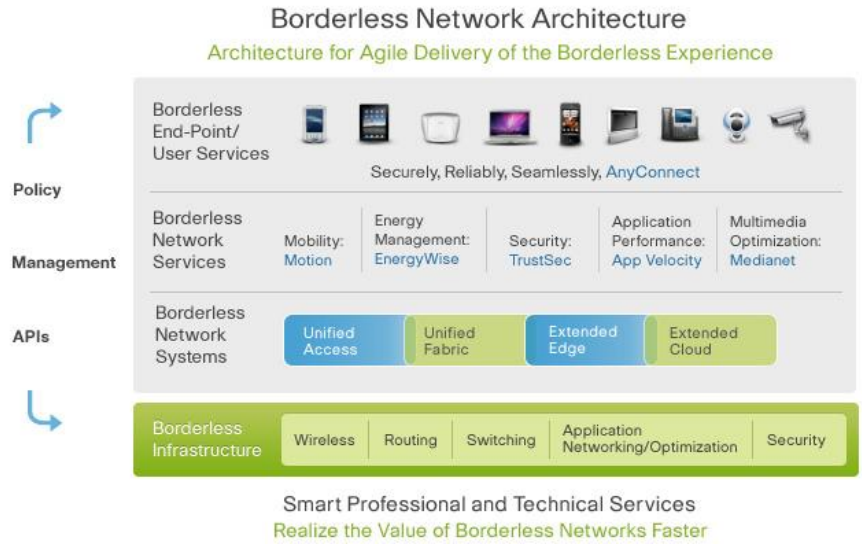
- **Total cost of ownership (TCO) advantage:** Multiservice systems and common automated management help lower capital and operating expenses. Key capabilities such as high availability, virtualization, and EnergyWise, help eliminate downtime and waste.

The Borderless Network Solution

The Borderless Network Architecture reduces operational complexity and provides network and user services to help enable the borderless experience. Borderless Network Architecture:

- Implements the flexibility to deliver transformative, network-based experiences.
- Provides control in an environment that supports students, faculty, administration, parents, and any other entity needed to enhance and further the district's educational goals and objectives.
- Connects anyone, anywhere, anytime, on any device - securely, reliably, and seamlessly.
- Provides a Network Foundation comprised of technology that is orchestrated to provide a concert of services to meet the demand of a user experience supported by security, multi-media, applications, mobility, and scale. The Network Foundation can no longer exist as a collection of point products that are playing off a different music score. The era of the "good enough network" is over as it just cannot keep up with the growing demands of its users.

Figure 1: Borderless Network Architecture



The Borderless Network Architecture delivers two primary sets of services: network services and user/endpoint services. Network services are end-to-end services delivered by the infrastructure that encompass routing, switching, mobility, security, and wide area network (WAN) optimization components:

- **Voice and video with medianet:** Extends rich-media experiences to partners, customers, and employees with scale and optimization.
- **Green with EnergyWise:** Measures, monitors, and controls energy usage on IT and non-IT

devices from the network for agility and efficiency.

- **Security with TrustSec:** Strengthens security across distributed networks with visibility and control to connect the right people, devices, and locations.
- **Mobility with Motion:** Provides anywhere, anytime access to information for wired, wireless, and remote users on any device to enhance participation.
- **Application performance with Application Velocity:** Enables the optimal experience of any application, at any time, and on any device, delivering a very fast application performance, using capabilities fully integrated into the Borderless Network portfolio. With application awareness built into the network, IT has an effective tool for managing application performance holistically.
- **Seamless user experience with AnyConnect:** Endpoint/user services, even though they are the functions of the network, define the user experience and enable the attributes of secure, reliable, and seamless performance on a broad range of devices and environments. AnyConnect is an example of device software that delivers secure, persistent, policy-based access for a seamless user experience.

Customer Benefits

The Borderless Network Architecture transforms the way IT manages scales, secures, and governs networks by linking users, devices, applications, business processes, and the network into a holistic, extensible architecture. A Borderless Network provides:

- A robust network platform capable of delivering real-time collaboration experiences to any device.
- Transparent mobility with location services for anytime, anywhere communications.
- Security for devices both on the local network and across cloud services.
- Sustainability and reduced energy costs for efficient and cost-effective business operations.
- Optimized application performance for rich-media applications.
- Policy-based access control and identity-aware networking to enable access and collaboration while protecting business-critical applications.
- Compliance with current and future government and industry regulatory requirements.

Future-Proofing

As we mentioned earlier, Technology is always rapidly evolving. If you don’t have a plan and you don’t know where you are heading, Technology will get the best of any IT organization. In light of the rapid advancements of technology and the growing demands of today’s applications, it is understandable that technology hardware and software have a finite value and the product lifecycles need to be monitored so business productivity does not suffer.

Existing products need to be measured by the benefits delivered and if those benefits have already been realized and been surpassed, then it’s time to take a look at the next steps in the technology evolution and make sure that next path chosen will be one that Sacramento City USD is able to walk a long for at least the next 5 if not 10 years.

A good example of this is the role switches play at the access layer. The new access layer switches (or edge switches) now provide enhanced features such as, Power-over-Ethernet, Power-voice-over-IP phones and wireless access points, Quality of Service and Traffic Shaping among other technologies.

- **Enhanced Power Over Ethernet:** Enhanced PoE offers more power, greater flexibility, and increased mobility to users with Enhanced PoE. This enables support for new services and applications, delivers maximum investment enhancement, and enables organizations to make the most of their network infrastructure today and into the future.
- **Quality of Service:** The ability to provide different priority to different applications, users, or data flows, or to guarantee a certain level of performance to a data flow. For example, a required bit rate, delay, jitter, packet dropping probability and/or bit error rate may be guaranteed. Quality of service guarantees are important if the network capacity is insufficient, especially for real-time streaming multimedia applications such as voice over IP, online games and IP-TV, since these often require fixed bit rate and are delay sensitive, and in networks where the capacity is a limited resource, for example in cellular data communication.
- **Traffic Shaping:** Provides the control of computer network traffic in order to optimize or guarantee performance, improve latency, and/or increase usable bandwidth for some kinds of packets by delaying other kinds of packets that meet certain criteria

All of these technologies, Enhanced PoE, QoS and Traffic provide the necessary network optimization to allow the Borderless Network to grow along with demand and technology as technology evolves to faster network speeds as well as more robust applications with regards to Video and Voice application technologies.

Return on Investment

The components of the Borderless Network Architecture not only will help Sacramento City Unified School District to lower operating and capital expenses, but also reduce costs that can be directly influenced by the network. Consider these: downtime results in lower productivity, constituent dissatisfaction, and decreased community brand; underutilized resources result in overspending on systems and support.

Through our technology partners, AMS.NET delivers well-tested, thoroughly documented solutions that reduce time to deployment and help you lower systems integration costs. One such example is the Smart Business Architecture (SBA) for midsize networks and enterprises. SBA offers a blueprint for designing and deploying a full-service, comprehensive network to support your business needs. It helps deliver prescriptive network design and deployment best practices for organizations with 100 to 10,000 endpoint devices.

SBA is designed to grow and evolve with your business, providing a platform for deploying advanced technologies from Borderless Networks, Collaboration, and Data Center architectures. In addition, AMS.NET has teamed with leading technology partners to provide a complete solution.

Additionally, Borderless Network Services help you drive operational efficiency:

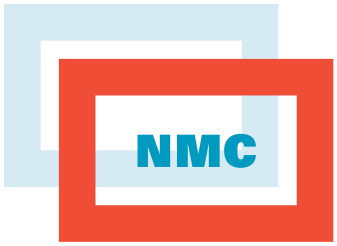
- **Medianet:** Handles video in the same seamless way that a robust network handles voice - endpoint detection, bandwidth, quality, prioritization, and normalization are all managed by the network. The end result is a high-quality experience that leads to higher classroom productivity. The network will self provision itself based on the video services negotiated between the video endpoint and the network. Video path monitoring provides critical insight in the provisioning, monitoring and trouble-shooting of video sessions.
- **Application Velocity focuses on delivering three key benefits:** maximizing user experiences, optimizing resource utilization, and increasing application reliability. This yields a superior user experience with up to 99% improved response time and a 90% cost savings in bandwidth.
- **TructSec:** Network security attacks cause a monetary loss of 3% against the total revenue. A

TrustSec solution implements access policies that limit risk, data breaches, and help ensure system availability; securing networks to minimize downtimes. Overall, the solution helps reduce costs, improve efficiencies, and lower OpEx.

- **EnergyWise helps organizations measure, report, and manage energy usage within the network:** Consider a municipality with 10,000 PCs spread across county offices. Without energy management, the annual energy costs for those PCs would be US $770,000. With EnergyWise in Catalyst switches, they can configure nightly shutdown of these PCs to save over one third of that amount - approximately US $280,000. With more aggressive energy management - putting PCs into sleep state and powering down monitors when users are away from their desks, they can realize another US $150,000 in savings. The total cost savings amounts to US $430,000 annually.
- **CleanAir technology:** Based on a recent technology survey of over 600 customers, 54% reported that RF interference impacted the performance of their wireless network, resulting in an inconsistent and unreliable mobility experience. CleanAir Technology, a Motion Network Service offers performance protection for 802.11n networks - increasing performance and reliability

Conclusion

Next-generation Borderless Network Architecture addresses key IT and business challenges by delivering a borderless experience to educational focused customers like Sacramento City USD. This means that your constituents can connect securely, reliably, and seamlessly - anywhere, anytime, on any device. ***Systems innovations*** across routing, switching, wireless, acceleration, security, video, voice and collaboration will enable Sacramento City Unified School District to transform the way you operate and educate today by delivering 21st Century tools / services over your network!



Sparking innovation, learning and creativity

Challenge Based Learning

The Report from the Implementation Project

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Challenge Based Learning

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Challenge Based Learning
The Report from the Implementation Project

The first major study of challenge based learning (CBL[1]) took place in the fall of 2009, when 321 students and 29 teachers in six US high schools embarked on a set of projects that spanned some 17 disciplines. The outcomes of that study, conducted by the New Media Consortium, were significant on a number of levels, not the least of which was the clear efficacy of the approach.[2]

Based on these results, in 2011 a second more in-depth study was conducted by the NMC that involved 19 institutions that collectively range from primary to graduate education, 65 teachers, and 1,239 students. This report details specifics about the study of those institutions.

Executive Summary

We know we have work to do to address the problems that face American public education.

We've known this for nearly three decades, since the publication of *A Nation at Risk* in 1983,[3] which powerfully documented that the United States had lost the advantage it briefly held in the world in science, commerce, technology, and industry; that as custodians of the education of the young, we were failing; that without immediate, conscious, and focused effort, that failure would only compound itself; and that in countries all around the globe, students were being better prepared to take part in a rapidly flattening marketplace than our own students were.

No such immediate, conscious, and focused effort has taken place. Until now.

After two major studies involving 24 schools in three countries and 15 states, over 1,500 students, and 90 teachers, it is clear that challenge based learning (CBL) is one of the freshest ideas that has emerged over that time, with replicable, scalable results for students at nearly every grade level. The approach is consistent with standards-based curricula, and does not require a massive reinvention of schools, nor the kind of top-to-bottom overhaul that some say is needed. It is based on a simple but powerful idea — make learning relevant.

1 Apple Education wrote a concept piece on the topic in 2009 that describes the method in considerable detail. See http://challengebasedlearning.org/cbl/global/files/CBL_Paper.pdf

2 This report can be downloaded at http://www.nmc.org/pdf/Challenge-Based-Learning.pdf.

3 National Commission on Excellence in Education. (1983). *A Nation at Risk: The Imperative for Educational Reform*. Retrieved from http://www.ed.gov/pubs/NatAtRisk/index.html A subsequent study 25 years later found that years of documenting results only underscored the issues. See *A Nation Accountable: Twenty-five Years After A Nation at Risk*. Retrieved from http://www2.ed.gov/rschstat/research/pubs/risk25.html

CBL makes learning relevant by giving kids problems big enough so that they have to learn new ideas and tools to solve them, but immediate enough so that they care deeply that solutions are found. Young people want to solve real problems, and that is exactly what challenge based learning is designed to do — give students and teachers a framework that makes learning relevant, and then let them dive in.

CBL is an idea that is simple and powerful — and even better, it works. Over the course of two extensive, field-based studies, the efficacy of the approach has been demonstrated by student work and the shared perspectives of teachers and students. Consider these four overarching findings from the Challenge Based Learning Implementation (CBLi) Study:

- ***CBL builds 21st Century Skills.*** Ninety percent of teachers reported that 12 key skill areas improved significantly, including Leadership, Creativity, Media Literacy, Problem Solving, Critical Thinking, Flexibility, and Adaptability. Seventy percent of teachers reported some improvement in every area of the 21st Century Skills.
- ***CBL engages students in learning.*** Over three-quarters of students, across every age group, felt that they had learned more than what was required of them, were part of solving a big problem, and worked harder than they normally do.
- ***Teachers find CBL effective in engaging students and helping them master the material — and a good use of their limited time.*** Over 90% of teachers, across every grade level, felt that CBL was a good use of their limited time and would use it again. Over three-quarters of teachers, again across every grade level, felt that their students mastered the expected material and that their overall engagement increased.
- ***While broadly applicable across the range of learning environments, CBL is ideally suited to teaching in a technologically rich environment.*** CBL works in a variety of settings, from those with shared access to computers and the Internet, to those with 24/7 Internet access via a combination of school and home-based devices, to fully one-to-one 24/7 classrooms. The study found that today's teachers and students already have the computer and Internet skills needed to engage with CBL effectively.

The Case for New Ideas

The reality remains that 28 years after *A Nation at Risk,* high school achievement for American students has not improved.[4] Even in the first five years under No Child Left Behind (NCLB), American students showed no gains whatsoever in reading, and very small ones in math.[5] While students in other nations enjoy rising scores and better preparation for a global workforce, our students suffer under a system that is known to not support their needs, stifled by a crippling inertia that limits new ideas.

Further, American students have a lower graduation rate compared to students in other industrialized nations.[6] Any benefit that would be gleaned by remaining in school is lost to those who drop out.

4 Strong American Schools. (2008). *A Stagnant Nation: Why American Students Are Still at Risk.* Retrieved from http://www.strongamericanschools.org/a-stagnant-nation-why-american-students-are-still-risk

5 Sanchez, C. (2007). U.S. Test Results Show Growth in Math, Not Reading. *All Things Considered,* National Public Radio. See http://www.npr.org/templates/story/story.php?storyId=14698611

6 Op. cit. *A Stagnant Nation.*

According to the National Center for Education Statistics (NCES), the proportion of American students who leave school before completing their degrees is increasing — and in recent years, researchers have reported that the figures may have been even higher than suspected due to inconsistent measurements.

We're failing our students because we are failing to engage them, and the results of this are dire.[7] In *One Third of a Nation,* Paul Barton describes the situation as an underreported problem.[8] Although the situation has drawn considerable attention from political leaders in the United States, we are still losing 30% of our students; it was only recently that we could even agree how to count dropouts. Students are also leaving school earlier; the majority of dropouts leave high school between grades 9 and 10.[9]

The evidence shows that one of the main reasons students are leaving is because they are disengaging from school.[10] While some factors leading to disengagement are related to their home life and family issues, it is becoming clear that an important factor is that students feel very strongly that what they are learning in school is not relevant to their lives.[11] Surveys of students who have left school have revealed that a lack of perceived connection between the curriculum and their everyday life or future work was a key factor, and many former students felt that more could have been done to keep them engaged through the type of schoolwork they were asked to do.[12]

We need new ideas.

We need ideas that will engage students and keep them learning. We need ideas that will encourage students to want to understand the world around them, and to help them see the relevance of math and science to their own lives.

Relevance is key, but too often it is all but absent from educational curricula. At the same time, genuine challenges are easy to find, and young people see the world as a place rife with problems they will need to solve in their lifetimes. They want and expect their schooling to prepare them for it, and when it does, engagement has shown to increase dramatically.[13] Even young children are deeply aware that the world economy, for example, is in a fragile state, and they have a clear sense of what a collapse would mean — to themselves, their families and friends, and to people across the country and around the globe. They realize that the planet's temperature is climbing, slowly but perceptibly, and that they may see the effects of that change in their lifetime. They understand that their lifestyles are built upon nonrenewable energy sources and they know some of what that implies. And, they see desperate hunger and poverty, sometimes not even very far from home.

7 Op. Cit. (Barton, 2005), (NCES, 2008).

8 Barton, Paul. (2005). Barton also notes that this likely results in inflated graduation numbers as well as underreported dropout rates.

9 See Haney (2004). Haney and others interpret these findings to be an indication that more students are being flunked to repeat grade 9, possibly in an effort to avoid passing students who are not likely to score well on 10th grade accountability tests and to keep reported passing numbers higher.

10 See Alspaugh (1998); Hernandez Jozefowicz-Simbeni (2008); Neild et al. (2008).

11 United States General Accounting Office (2002).

12 See Bridgeland, et al. (2006), in which 71% of respondents reported losing interest in their freshman or sophomore year; 47% reported that they left school because the class work was uninteresting.

13 Op. Cit. *Challenge Based Learning: An Approach for Our Time* (2009). This study of six schools produced self-reported engagement rates from students of 90% and higher among 9th graders.

There are real problems that need solving, and young people understand that no less than adults do. They see these important issues taking the international stage and they know that school is not preparing them to address them. One in three makes the choice to leave.

What is needed is a new idea, one that engages students' curiosity and desire to learn. It must make the solving of real problems the center of the curriculum, give students access to digital age tools, and require them to work collaboratively and manage their own time. And, it must allow students to direct the course of their learning and engage teachers in a supportive, very necessary role as guides.

That new idea is challenge based learning.

Challenge Based Learning

Challenge based learning is a multidisciplinary approach to education that encourages students to leverage the technology they use in their daily lives to solve real world problems. By giving students the opportunity to focus on a challenge of global significance and apply themselves to developing local solutions, CBL creates a space where students can direct their own research and think critically about how to apply what they learn.

The result, as evidenced in the pilot and this current study, is increased engagement, extra time spent working on the challenge, creative application of technology, and more student satisfaction with schoolwork. Students mastered the subject-area content and their engagement with the material and with learning improved.[14] The concept is detailed in a white paper produced by Apple, Inc.:

> ***Challenge based learning is a collaborative learning experience in which teachers and students work together to learn about compelling issues, propose solutions to real problems, and take action. The approach asks students to reflect on their learning and the impact of their actions, and publish their solutions to a worldwide audience.***[15]

Challenge based learning builds on the practice of problem-based learning, in which students work on real world problems in collaborative teams, but with key distinctions that add a great deal of relevancy for students. At the center of challenge based learning is a call to action that inherently requires students to make something happen. They are compelled to research their topic, brainstorm strategies and solutions that are both credible and realistic in light of time and resources, and then develop and execute one of those solutions that addresses the challenge in ways both they themselves and others can see and measure.

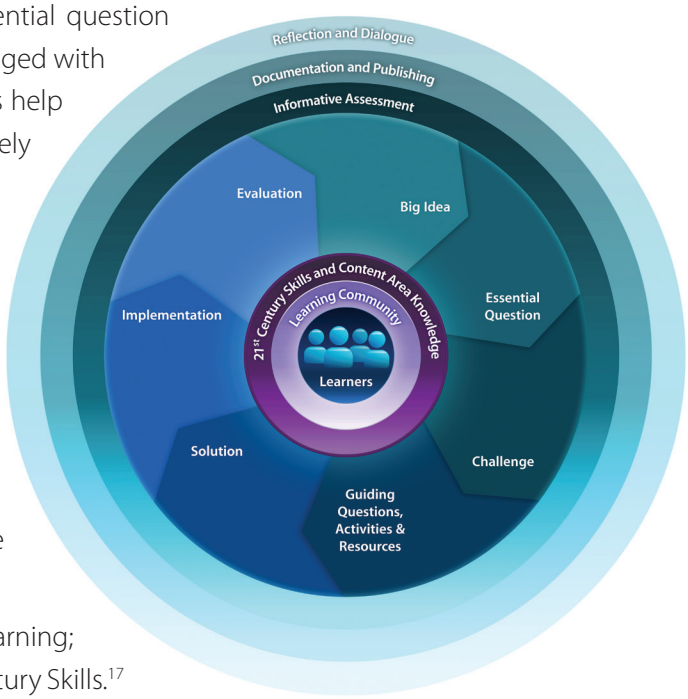
The challenge based learning model is a direct response to the growing concerns within the education and business communities that most high school graduates lack abstract thinking, problem solving, self-directed learning, the ability to work in groups.[16] Challenge based learning was designed to promote creativity and risk-taking within a framework that assures the students have both a fertile topic to explore those skills, as well as the freedom to do so.

14 In both the pilot and the implementation studies, more than three quarters of teachers, across every grade level represented, reported that their students mastered the expected material and that their overall engagement increased.

15 Op. Cit. Apple Education (2009). *Challenge based learning.*

16 See Ward and Lee, "Teaching Strategies for FCS: Student Achievement in Problem-Based Learning Versus Lecture-Based Instruction."

The essential elements are laid out in the accompanying figure. A big idea is a concept with far-reaching significance, such as biodiversity, strife, sustainability, or resilience. The essential question creates a more specific focus for the big idea and guides the students toward manageable aspects of the larger concept. The challenge is framed to bring the big idea and essential question home with a local call to action. Once students have engaged with the challenge, guiding questions, activities, and resources help them to craft a solution, implement, evaluate, and ultimately publish their results via the web and video.



Access to technology is an integral part of challenge based learning, and not only provides a means for students to explore as they begin to think more imaginatively, but also gives them tools to communicate their work. Challenge based learning is highly adaptable, and works in a wide variety of learning environments and situations. It is ideal in one-to-one settings, as 24/7 access to tools and the Internet only encourages students to extend the school day as they tackle the challenge.

Teamwork is another key ingredient of challenge based learning; working in groups allows students to hone many 21st Century Skills.[17] Working together, students are able to correlate research on their challenge to events taking place in their communities, ultimately strengthening the connection between what they learn in school and what they experience outside of it.

What was conveyed in the pilot study is now even more clear in the research and case studies from year two: the evidence indicates that challenge based learning motivates students to come to class and do well[18] — especially those students who may be seen as at-risk. This is a direct result of the increased level of engagement that CBL affords. Students can learn more flexibly, in an atmosphere where it is clear that a problem often has more than one solution, or more than one path to the optimal solution. They have more opportunities to showcase their personal skills and talents, and to act on their own ideas. All of these factors were shown to be positively related to engagement.

While the common thread of the challenges in this study remained the same as that of all CBL challenges — think globally, act locally[19] — the range of themes expanded considerably in the implementation project, from saving money to providing relief to natural disaster victims to finding ways to reduce waste in the community. Four case studies are presented as an appendix to this report to demonstrate that spectrum. The choice of schools for the cases reflects the diversity of the age groups and the challenges, and each includes a discussion of local student and teacher outcomes.

17 See http://www.21stcenturyskills.org/ for both the 21st Century Skills Framework and an excellent set of resources.

18 More than three quarters of teachers, across every grade level, felt that their students mastered the expected material and that their overall engagement increased. See the section on Major Findings for considerably more detail.

19 A wide range of challenges can be found at http://challengebasedlearning.org

The Challenge Based Learning Implementation Study

The purposes of the Challenge Based Learning Implementation Study (CBLi) were two-fold, and blended in some ways the long-standing boundaries between outcomes- and process-focused evaluation and more traditional educational research.

The first purpose was to determine if the outcomes and findings of the pilot could be replicated and extended beyond the purely high school focus of the pilot to other educational levels and settings, especially as they fall into four areas: the overall student experience; the overall teacher experience; the match of CBL learning outcomes (particularly informal learning outcomes) with key skills described in "Framework for 21st Century Learning";[20] and the learning goals for the time devoted to the work.

The second was to add additional understanding of several aspects of the school ecosystem that may influence the success of challenge based learning. Among these are the importance of training and support in the implementation of CBL; the impact of

SCHOOL/UNIVERSITY	LOCATION	CHALLENGE
Elementary Schools (grades 3-5; ages 8-11)		
Echo Horizon School	Culver City, CA	Improve quality or consumption of water in your community.
Jamestown Elementary School	Arlington, VA	Use creativity to solve a problem.
Startzville Elementary School	Canyon Lake, TX	Help me find my place.
Wildwood World Magnet	Chicago, IL	Feed the hungry.
Middle Schools (grades 6-8; ages 11-14)		
Culbreth Middle School	Chapel Hill, NC	Increase sensitivity!
Kamehameha Middle School	Honolulu, HI	Take care of the land.
LaGrange Highlands Middle School	LaGrange, IL	Reduce waste in your school or community.
Ocoee Middle School	Ocoee, FL	Actively participate in the political process.
High Schools (grades 9-12; ages 14-18)		
Arizona School for the Arts	Phoenix, AZ	Connect people.
Mercy High School	Farmington Hills, MI	Design a better cafeteria experience.
San Bernardino High School	San Bernardino, CA	Improve your wellness.
Toledo Central Catholic High School	Toledo, OH	Improve nutrition in your school and community.
Westside High School	Omaha, NE	Improve family dynamics.
Colleges/Universities (undergraduate; adult learners 18 and above)		
Full Sail University	Winter Park, FL	Foster community.
Houston Community College	Houston, TX	Find ways to save!
Ball State University	Muncie, IN	Inform and engage your community about fuel ethanol production.
Miami University	Oxford, OH	Make undergraduate education relevant!
International Schools (grades 5-8; ages 10-14)		
Calgary Science School	Calgary, Alberta Canada	Make more environmentally ethical food choices!
Ringwood North Primary School	Melbourne, Victoria Australia	Help a community recover from a disaster.

20 The Framework describes "21st century student outcomes" as the knowledge, skills and expertise students should master to succeed in work and life in the 21st century. The nine-page report can be downloaded at: http://www.p21.org/documents/P21_Framework_Definitions.pdf

student groups on outcomes; a greater understanding of the skills and resources needed for a teacher to successfully implement CBL; and a sense of if (and how) a CBL approach might extend learning to times and places outside the traditional classroom.

With these goals in mind, the CBLi project was launched in January 2011, with a meeting of the 56 teachers participating in the effort. The primary goal of the two-day workshop was to ensure the participants understood CBL well enough to implement it to a baseline standard, with the secondary goal of giving them dedicated time to identify a big idea for their school, tease out essential questions, and frame their challenges. The 19 schools and universities involved then worked to implement those challenges through late May 2011.

The Schools

The participating schools were chosen against several criteria. The researchers were looking for schools that genuinely were interested in challenge based learning, and that would have sufficient support and resources to successfully implement the approach.

In addition, the group was selected so that a wide range of grade levels could be included. Thus, four elementary schools, four middle schools, five high schools, and four colleges and universities were selected, along with two international schools, one in Canada and one in Australia. In addition, a mix of public, private, and parochial schools was intended.

GRADE LEVEL	STUDENTS	PROPORTION
3rd Grade	23	2%
4th Grade	22	2%
5th Grade	134	11%
6th Grade	215	17%
7th Grade	242	20%
8th Grade	107	9%
9th Grade	144	12%
10th Grade	72	6%
11th Grade	108	9%
12th Grade	77	6%
Community College	40	3%
University	55	4%

STUDENT RACE/ETHNICITY/GENDER	ALL US	PROJECT SCHOOLS
White	51%	61%
Black	14%	6%
Hispanic	26%	9%
Asian/Pacific Islander	5%	10%
American Indian/ Alaska Native	1%	0%
Multi-Ethnic	—	7%
Unreported	—	6%
Male	52%	45%
Female	48%	55%

Demographics

The CBLi study included 1,239 students and 65 teachers and administrators. In terms of ethnicity and gender, the sample was less diverse and more female than the general population of school age persons.

Teachers in the study were generally older, with the mean at about 37 years of age, and experience levels to match at about 8 years in the classroom. The teachers in the study were disproportionately male; just 30% of teachers across all levels are male in the US.

TEACHER GENDER/AGE	PROPORTION	TEACHER EXPERIENCE	PROPORTION
Male	67%	Less than 1 year	2%
Female	33%	1-3 years	13%
Younger than 25 years old	5%	4-6 years	12%
26-35 years old	30%	7-10 years	29%
36-45 years old	37%	More than 10 years	44%
46-55 years old	16%		
Older than 55 years old	13%		

Major Findings

The study included four major areas of principle focus, with the summative assessment of the effectiveness of CBL at the top of that list, followed by expanding the understanding of the teacher and student experience, and, finally, a closer look at four general areas thought to be mitigating factors in the success of a CBL implementation. These included teacher training and support; the impact of the composition of student groups on outcomes; needed skills and resources; and time and place changes in student learning practice.[21]

The major findings of the study are detailed below. Subsequent sections provide additional supporting information for these overarching findings, as well as other findings related to the student and teacher experience and the four mitigating factors that were examined.

1. CBL is effective in building 21st Century Skills

- ***90% of teachers reported these 12 key skill areas improved significantly (in rank order)***

Leadership	Creativity
Media Literacy	Problem Solving
Collaboration	Critical Thinking
Flexibility	Communication
Adaptability	Innovation
Responsibility	Initiative

- ***80% of teachers reported that these additional six key skill areas improved as well (in rank order)***

Productivity	Social Skills
Accountability	Self Direction
Information Literacy	Global Awareness

- ***70% of teachers reported some improvement in every area of the 21st Century Skills***

21 The notion of time and place changes in the ways learning happened is significant. We were specifically interested in whether or not the teacher and students were able to extend the classroom temporally or virtually in ways that have students working beyond the school day and/or interacting with experts in relevant fields.

2. CBL engages students in learning.

- ***Over three-quarters of students, across every age group, felt that they had learned more than expected, were part of solving a big problem, and worked harder than they normally do.***

STUDENT SUCCESS OUTCOME STATEMENTS	PROPORTION OF STUDENTS IN AGREEMENT
I learned a lot	79%
I helped to solve part of a big problem	76%
I worked harder on the CBL project than I normally work on my schoolwork	75%
I felt like I was doing something important	75%
I realized I could be a leader	73%

> *"I feel everyone partaking in this study is making a difference. The way we make a difference is by giving solutions to problems and fixing them. Even a kid can make a difference somehow."*
>
> ELEMENTARY SCHOOL STUDENT

3. Teachers find CBL effective in engaging students and helping them master the material — and a good use of their limited time.

- ***Over 90% of teachers, across every grade level, felt that CBL was a good use of their limited time and would use it again.***

> *"Even the 'failed' solutions or the solutions lacking creativity still took students through a problem solving, dynamic, group task where setting a schedule, being innovative, researching, amassing new knowledge and sharing it with others, and implementing an idea to pass on information to others ended up giving them useful real world experience."*
>
> HIGH SCHOOL TEACHER

- ***Over three-quarters of teachers, across every grade level, felt that their students mastered the expected material and that their overall engagement increased.***

INSTRUCTIONAL SUCCESS OUTCOME STATEMENTS	PROPORTION OF TEACHERS IN AGREEMENT
CBL was a good use of my class time and resources	93%
I intend to use CBL again	91%
My students mastered the expected material	79%
Overall engagement of my students increased during the project	75%

- ***Overall, teachers felt that CBL was a refreshing change.*** After just a single implementation cycle, 94% of teachers felt they understood CBL; 73% felt they understood it well, and they felt the approach made their role more responsive, coach-like, and individualized. Teachers reported deeper conversations with the students about their projects and what learning approaches were/were not working for them.

4. CBL is ideally suited to teaching in a technologically rich environment.

- ***While CBL is beneficial in many kinds of learning environments, it is particularly effective in classrooms where every student has 24/7 access to computing resources at home and at school.*** CBL creates an expectation from the first steps that students will use technology to research their topic, to collaborate among their group, capture reflections, present and publish their work, and more. Along the way, they reinforce digital media skills they may already have, and extend those

skills in areas such as music, video, and more. A related aspect is that students are expected to think critically about their message and the media used to convey it.

- ***Today's teachers and students already have the technical skills needed to engage with CBL effectively.*** Both students and teachers felt their computer, Internet, and digital media skills were sufficient to the demands of CBL. Teachers' technical skills did not rank among their top five concerns after the project, and technical skills improved for both teachers and students as a result of CBL. Video skills are somewhat of an exception: a significant number of teachers (34%) reported that they underestimated the importance of video skills in particular for their own needs and for those of students to a degree that it took time away from other tasks.

Summative Outcomes

For the CBLi study, success was defined on three levels, each progressively more important in the overall picture. The first was *Implementation Success,* which focused on the process of using CBL, how well that went for teachers and students, whether or not the challenge was completed, and how teachers and students perceived the impact of the solutions. The second was *Instructional Success,* which primarily focused on how well the approach worked with the required curricula, the teacher's own teaching goals, and how well CBL meshed with the ebb and flow of the classroom. The key outcome for this component is that the students learn what they need to, and at the levels they need to.

Ultimately, however, the success of challenge based learning is determined by how it spurs students to learn, and so the third and most critical component of the model is *Student Success.* Student success looks beyond the basic instructional goals to see what other things students learned. Did they develop or improve key 21st century skills such as media literacy, creativity, innovation, teamwork, collaboration, and critical thinking? Were they flexible and adaptable? Did they show leadership and assume responsibility? Did they effectively utilize technology? Did they learn more than was required? Did the solution impact their community?

Implementation Success. Operationally, CBL is a process, and the degree to which CBL was well implemented constitutes one level of success in our three-tiered model. Were all the components included? Did it present workable solutions? Did the effort reach its logical ending? Did it accomplish its stated goals? Understanding the answers to these questions revealed how the process worked, with implications for future implementations. For this study, implementation success was defined as the degree to which the CBL process was understood and implemented. In particular, this component of success included these questions:

- How well did the CBL process go for teachers and students?
- Was the challenge completed?
- What was the perceived impact of the solution for teachers and students?

Eighty-eight percent of teachers in the CBLi project characterized their implementation as successful. Students echoed this perception; 76% also rated their effort as successful. An analysis of the 270 comments left by those students who did not rate their project as successful, however, clearly shows that for them, operational success was associated with their perception of the project's impact, so it is likely that further analysis would indicate stronger agreement between teachers and students on this dimension.

There were recurring references to hurdles in the implementation of CBL, and 20% of teachers described their implementation experience as "very hard." In almost all cases, this was related to issues with producing video, which is a major component of CBL. Students, on the other hand, tended to refer to group process issues as the biggest obstacle for them.

Instructional Success. The middle tier of our success model looked at the teacher experience closely to see how the approach worked for students in grades three through 16. Teachers across all grade levels reported strong outcomes in this dimension. The aspects of instructional success that most interested us were:

- How well did the approach work with the required curricula?
- How well did the approach work with the teacher's own teaching goals?
- How well did CBL mesh with the ebb and flow of the classroom?
- Did the students learn what they needed to, and at the levels they needed to?

Most of the teachers in the study — well over 90% — were new to CBL. The fact that ratings about their intentions related to using CBL again were over 90%, and how it worked with time and resources even higher, indicates an optimism for the process that is significant.

INSTRUCTIONAL SUCCESS OUTCOME STATEMENTS	PROPORTION OF TEACHERS IN AGREEMENT
CBL was a good use of my class time and resources	93%
I intend to use CBL again	91%
My students mastered the expected material	79%
Overall engagement of my students increased during the project	75%

> ***"Instead of being teacher-centered in front of the classroom, this is much more of a student-centered approach… I'm in teaching because student education should be focused on the students. So in that regard you have to remove yourself to some extent and help students find the resources they need. We like to call it 'responsive teaching' because that's really what you're doing."***
>
> HIGH SCHOOL TEACHER

Student Success. Ultimately, any measure of success in teaching and learning must document what actually happens for students, and so the third component of the three-tiered model, student success, has been considered the most important from the earliest design, and the dimension that has received the most focus in the analysis components of the study to date. Among the key questions of interest were:

- Did individual students develop or improve key 21st Century Skills such as media literacy, creativity, innovation, teamwork, collaboration, and critical thinking?
- Did students demonstrate flexibility and adaptability?
- Did students show leadership and assume responsibility?
- Did students effectively utilize technology?
- Did students learn more than was required?
- Did the students' solutions impact their community?

"My joy comes from their joy, and now that they are on board as much as they are, I will say I'm just very grateful to be part of this process. Specifically because the learning is all being generated by the kids and they have a tremendous amount of ownership, which is the way it should be."

MIDDLE SCHOOL TEACHER

A strong correlation emerged between two aspects of the student experience and student success — when students perceived the problem as important, a host of other measures went up, including time on task, how much they learned, and more. Additionally, if they felt like their own work made a significant contribution, the same factors increased.

Overall, the following statements found strong student agreement among those who felt that their project was important, and for those who felt that their own work made a difference it was especially strong:

INSTRUCTIONAL SUCCESS OUTCOME STATEMENTS	PROPORTION OF STUDENTS IN AGREEMENT
I learned a lot	79%
I helped to solve part of a big problem	76%
I worked harder on the CBL project than I normally work on my schoolwork	75%
I felt like I was doing something important	75%
I realized I could be a leader	73%

Eighty percent or more of teachers rated all but five 21st Century skills as improved during the CBL project; if the bar were lowered to two-thirds of teachers, all of the 21st Century Skills improved as a result of CBL. Twelve of the key skills, including leadership, responsibility, creativity, communication, critical thinking, innovation, and others widely correlated with success in the workplace were rated highly by over 90% of teachers.

Students echoed this finding, although their ratings were in general somewhat lower than teachers. The most improved skills in the students' estimation were leadership, responsibility, productivity, flexibility and adaptability.

"I feel really good and it is a big experience for me because we are doing a lot to help our school and world… It is fun in a good way."

ELEMENTARY SCHOOL TEACHER

21ST CENTURY SKILLS RATED AS IMPROVED	IMPROVED AS ASSESSED BY 80% OR MORE OF TEACHERS	IMPROVED AS ASSESSED BY 80% OR MORE OF STUDENTS
Leadership	98%	86%
Media Literacy	96%	82%
Collaboration	95%	81%
Flexibility	94%	84%
Adaptability	94%	84%
Responsibility	94%	85%
Creativity	93%	83%
Problem Solving	93%	83%
Critical Thinking	92%	76%
Communication	91%	77%
Innovation	90%	81%
Initiative	90%	80%
Productivity	89%	85%
Accountability	89%	82%
Information Literacy	88%	81%
Social Skills	88%	82%
Self Direction	84%	82%
Global Awareness	83%	75%
Civic Literacy	77%	82%

The Student Experience

Probably the most unanticipated finding of the study was that there were no striking differences in the student experience between students at different grade levels and ages, other than those attributable to the dynamics of the student working groups within the classroom. (This particular dimension is covered in depth in a subsequent section.) On average, students devoted about 90 minutes a day to CBL at school; work outside of class occurred primarily at home and served to extend the learning day by an average of one hour. Both students and teachers commented on the noticeable increase in overall engagement of students in the work.

> ***"Probably the biggest thing that we've noticed is just how much more engaged the students are with the work that they're doing."***
>
> HIGH SCHOOL TEACHER

Interestingly, 80% of students felt that they did most of the work in their group, supporting the finding of strong engagement among the students around the group activities.

The most compelling finding related to the student experience was the strong shift that occurred in students' perceptions of how they might contribute to a group project over the term of the project. Fewer than 15% saw themselves in a role such as leader, creative contributor, or strategist before the project began, but by the end, most students listed all these and several other ways in which they contributed to the work of their groups.

STUDENT EXPERIENCE: WORKING IN GROUPS	PROPORTION OF STUDENTS IN AGREEMENT
I usually contribute by sharing ideas and strategies	95%
I like to be sure the group turns in good work	94%
I like to be the creative person in the group	88%
I am the one who usually does most of the work	80%
I like to be the group leader	79%

The tendency of students to increasingly see themselves as leaders was especially strong among minority groups in middle schools, which is an especially appropriate time to allow a young person to see themselves in roles they perceive as positive.

Eighty-four percent felt that their project was likely to impact the overall problem; nearly half felt that it definitely would. At the same time, student confidence in their ability to impact the overall problem diminished slightly, although significantly. Students proved to be good judges of their own contributions; there was virtually no difference in their assessment of whether the things they would do (pre-project) and did do (post-project) would make a difference in their group's efforts.

> ***"CBL has been a very different type of learning experience. It has required me to problem solve and think outside the box, which is both a challenge and a relief from the usual mundane subjects in school. CBL is a class in which I can learn more about what truly interests me and what will further me as not only a student in America, but a student in the world."***
>
> HIGH SCHOOL STUDENT

Students clearly enjoyed the feeling that they were "making a difference." An analysis of comments from 178 students in midterm interviews strongly underscored this; major themes that emerged from those comments were:

- Overall, there was an overwhelming sentiment from students that they were making a difference at their schools and in their communities, which added to their own engagement with the project.
- The younger students, especially, were very pleasantly surprised that they were able to make a community impact even though, as one elementary student put it, they were "just children, still in school."
- Students feel more connected both to their schools and to their communities.
- Many students want to continue to help their communities after CBL.

> ***"I feel I am making a difference because of this project in our community. We are going through with our solution [no matter the outcome]…"***
>
> HIGH SCHOOL STUDENT

Before the project began, students overall rated their own computer and Internet skills very highly ("strong" or "very strong") and even their video production skills at 3.84 on a five-point scale. Nonetheless, more than two-thirds reported these skills as improving over the term of the effort.

> ***"A lot of people have stepped up in other ways, too, not just with the projects they're working on but also by sharing skills. People who are good at computers help people who aren't. People who are good at filming help people who aren't. So we had a bunch of little sessions [where] the students actually taught other students needed skills."***
>
> HIGH SCHOOL TEACHER

> ***"It's been a chance [for the students] to use all the skills they've learned throughout their entire education and apply them in a real world setting."***
>
> HIGH SCHOOL TEACHER

Group Assignments and Student Outcomes

Teachers by and large became attuned to the notion of the effects of group assignments on student outcomes through the CBLi project; only 48% described themselves as attuned to the impact of group assignments on student outcomes initially, but by the end of the project, 96% described the group interactions among and between their students as important to the overall outcomes. Students concurred, and a great deal of the student commentary was devoted to the assignment of students to groups.

> ***"I am an independent person, so I usually feel that working in groups wastes a lot of time and sometimes it's not fair. I can complete a lot by myself. CBL has changed that because when I get to choose my group members, I choose ones that I know will work hard. I am happy that we got to work in groups because it gets things done faster."***
>
> MIDDLE SCHOOL STUDENT

The sentiment above was echoed throughout the student comments, both by those who felt their groups were appropriate and by those who did not. Concern about the composition of groups was strongest in grades seven through 10 — formative years when concerns about group and individual identity are paramount. To better understand this phenomenon, students were randomly selected for interviews at the approximate midpoint of the process and 178 students submitted written comments.

Five key themes emerged from those interviews related to group dynamics, including a number related to the ways students work together in a CBL project; the ways they prefer their groups to be chosen, and how groups handled conflict:

- Many students' opinions about working in groups changed over the course of the project enough for them to comment on the change; CBL was perceived to have brought about a heightened level of collaboration and positive group dynamics.
- Comments about group dynamics tended to be more positive when students were in charge of choosing their own CBL teammates
- The most positive comments came when the workload in the group was distributed according to the kinds of activities each student excelled at. Some handled digital media very smoothly, while others demonstrated talents for planning and presenting. Because of this, there was a marked increase in peer-to-peer learning as they taught each other new skills.
- Many students commented that they formed good relationships with their teammates that they would never have formed otherwise.
- Conflict caused setbacks, but when groups were able to pull through that, it became a source of pride.

Despite these positive comments, on average, students reported that they liked working in groups less after the CBL project completed. An analysis of student comments suggested that the dynamics within their groups was a major factor in this small but significant decline. The mean for student responses (on a five-point scale from "really dislike" to "really like") to a question of how much they liked or disliked working in groups was 3.93 (liked) before the project, and 3.72 after the project.

In contrast, large numbers of students seemed to view group work post-project in generally positive terms:

> ***"I usually despise working in groups but CBL has changed the way I approach group work. Through CBL I have found some new forms of compromise. But the most important thing that I've realized is that any effective and significant, challenging work you hope to do, 98% of the time cannot be done alone."***
>
> HIGH SCHOOL STUDENT

This perspective was echoed strongly in the student post-survey:

WORKING IN GROUPS (POST PROJECT PERCEPTIONS)	PROPORTION OF STUDENTS IN AGREEMENT
When a group works well together, they help each other do their best work	95%
Working in groups lets people develop new skills	94%
Group work is more fun because it is more social	88%
Groups are more exciting than the more individual kinds of school work	80%
In most groups, one or two people end up doing most of the work	79%

When students were asked to make a forced choice among the dimensions in the table above, 53% chose the first item, "When a group works well together, they help each other do their best work," while the next highest choice was just 17%, who selected "In most groups, one or two people end up doing all the work." The last result in the table above contrasts with the finding noted above that 80% of students were the person doing the most work in a group. More research is needed to understand this disparity.

Overall, these results tend to support the importance of the social dimensions of the classroom, especially as it relates to the assignment of groups. It seems clear, especially from the student comments, that who they are asked to work with is a very important factor in how students feel their group will work. At the same time, beyond that observation, it is clear that there is room for considerably more study of this area.

The Teacher Experience

Teachers overwhelmingly found CBL easy to learn and understand — after a single implementation cycle, 94% of teachers felt they understood CBL; nearly three-quarters felt they understood it well, while one-fourth felt they were expert enough at it to teach others.

> ***"I've taught for 22 years. I find it very stimulating to do something new with my students."***
>
> HIGH SCHOOL TEACHER

Nonetheless, teachers tended to underestimate the time that CBL would take to implement as a portion of their normal work day. Most teachers (98%) estimated that CBL would take only a modest amount of time away from other tasks. By the end of the project, 56% reported that it did, in fact, take time away from other important tasks. The primary reason, culled from a list of comments from a random sample of teachers, was that teachers underestimated the importance of video skills to both themselves and to students. Time pressure related to project deadlines took time away from other tasks to which they would normally have devoted themselves.

In other areas in which teachers anticipated issues, their perceptions were fairly accurate:

TOP FIVE CONCERNS	ANTICIPATED	ACTUAL
Time away from other tasks	52%	56%
Student skills	40%	38%
Time outside of school	40%	25%
Mastering CBL quickly enough	37%	25%
Adequate training / professional development in CBL	31%	12%
Access to needed equipment	19%	21%

> ***"I tend to be very organized, like I know what I'm teaching today and I know X,Y, and Z and that's where my comfort level is, or so I thought. But I am finding I am very comfortable letting the children decide the direction we're going in, which is kind of new for me."***
>
> **6TH GRADE TEACHER**

Fifteen of the 62 teachers were selected for mid-project interviews, which were conducted via telephone, and then transcribed and analyzed for recurring themes. Five themes emerged:

- Overall, teachers found it refreshing to step into a different role with CBL.
- Teachers felt their role was more responsive, coach-like, and individualized.
- Teachers began instigating deeper conversations with the students about their projects and what learning approaches were/were not working for them.
- Many teachers took a while to feel sure-footed about leading the CBL projects because it felt like a fairly big departure at first. They had to change their mindsets and become more trusting of their students, which was initially difficult.
- Finding ways to effectively communicate and present the CBL model and essential question to the students proved challenging; some teachers had to take a step back mid-process and re-present the project to their students in a different way. Teachers reported a lot of "learn-as-you-go" experiences.

Required Skills and Resources

Teachers identified five essential skills that found virtually universal agreement. Topping the list were the teacher's own digital skills, reflecting the strong connection of CBL to 21st Century Skills such as creativity and media literacy. Equally important were subject matter expertise and facility with CBL. While none of the teachers or students reported behavioral or other issues during the project, it is significant that 94% of teachers listed classroom management as an essential skill.

The ability to make students feel comfortable with the process and to work with them as they go through the open processes of brainstorming and working through the steps of challenge based learning are very much dependent on the atmosphere the teacher is able to create and maintain. Done well, it may not be obvious, but teachers agree that it is very important.

TEACHER PERCEPTION OF ESSENTIAL SKILLS	TEACHERS IN AGREEMENT
Digital media skills	99%
Internet skills	98%
Subject knowledge	98%
Understanding of CBL	98%
Classroom management skills	94%

Training and Support

A clear finding was that while teachers are able to learn CBL and implement it, the skills it requires are new to many of them. After the project ended, only 13% of teachers reported that they had all the skills and training they needed at the beginning of the effort. At the top of the list of recommendations they had for other teachers or schools was to provide training in the approach; 86% reported that the CBL training they received in Dallas at the project kick-off helped them to be successful. Three-quarters felt the online CBL community space was important to their ability to craft successful implementations.

Unsurprisingly, given the way the schools were selected, 98% felt they had sufficient administrative support; 94% felt they had sufficient technical support, as well.

While the teachers self-assessed their general computer skills at 4.02 out of five ("strong") and their general Internet skills at 4.17 (also "strong"), many of them found their digital media skills posed issues. Although almost all of them were able to learn the tools and techniques they needed, it took time away from other tasks to do so. Video and editing skills topped the list of activities in which they wished they had a stronger footing — a finding with clear implications for pre-service education.

WHAT DO YOU WISH YOUR PAST PROFESSIONAL DEVELOPMENT HAD INCLUDED BEFORE YOU BEGAN YOUR CBL PROJECT?	PROPORTION OF TEACHERS IN AGREEMENT
Video editing	50%
Audio editing	37%
Formal CBL training	33%
Image editing	19%

Time and Place Changes in Student Learning Practices

The researchers were able to document that CBL did effect time and place changes in the ways students learned, both inside and outside of class. On average, students devoted about 90 minutes a day to CBL at school; teacher and student comments indicate that this work involved more freedom and student choice in the manner they were able to approach their tasks and the resources they used. Work outside of class occurred primarily at home (64% of students) and served to extend the learning day by an average of one hour. This finding was true across all grade levels.

Related to this dimension were changes in the adults from whom students were learning. While the vast majority of students (88%) still listed their teacher as a key resource to them, 47% of students reported local experts as significant contributors to their learning; 36% called upon parents, and 32% noted that other family members were a significant help.

Technology

The students' and teachers' perceptions of technology, and their comfort with both the tools and their own skill sets were a key focus of the research, as the very nature of CBL presumes extensive access to technology. Indeed, CBL is a pedagogy that seems ideally suited to teaching in one-to-one classrooms, and especially where every student has access to an Internet-capable device at home and in school. Having such access allows students to continue to muse and reflect on their challenges, and as the previous section demonstrated, extends the school day and expands the classroom.

Teachers were asked to provide a great deal of specificity about the technological resources they used in their CBL projects, and of special interest were those in which teachers shared a broad agreement on their importance. This was explored both in terms of technology for their own use and for students.

TEACHER PERSPECTIVE OF THE IMPORTANCE OF KEY RESOURCES	FOR TEACHER USE	FOR STUDENT USE
Internet access in class	98%	100%
Personal laptop	94%	96%
Video camera	-	96%
Video editing tools	82%	94%
Audio capture and editing tools	-	94%
Digital still camera	-	94%
Internet access outside of class	98%	92%
Microphone	-	86%
Image editing tools	-	86%
Data projector	80%	-

Resources with less than 80% agreement on their importance are omitted.

Four Case Studies

Four representative schools, one from each level of institution — primary, middle school, high school, and university — were selected by the researchers for additional in-depth study. These case studies provide more information about how the schools actually approached their implementations, how educators worked with students, and what they accomplished.

Ringwood North Primary
Melbourne, Australia

Big Idea: *Resilience*

Question: *How can we better support each other during times of hardship?*

Challenge: *Help a community recover from a disaster.*

Overview: *Throughout history, the human race has continually been challenged by disasters. During these times of great adversity, communities need to come together and support one another. Australia's Ringwood North Primary School challenges you to make a difference for a community affected by a disaster.*

Technology: *Ringwood is a one-to-one iPad school*

Ringwood North Primary chose a very timely subject for their challenge based learning project. In the midst of their challenge, "Help a community recover from a disaster," Christchurch, New Zealand experienced a tragic earthquake and Japan was rocked by a giant tsunami. While the project was initially focused on helping communities in Australia affected by floods and cyclones, the challenge took on a more global perspective as graphic images of the devastation moved their students into taking action.

The participating students were fifth and sixth graders, ages 10 to 12 — a significantly younger age group than the challenge based learning pilot high schools. One of the missions underscoring their role in this study was to explore how CBL translates to the elementary school set. The children created a challenge without a concrete end, developing solutions that are highly transferrable to different scenarios. "The highlight of this project has been to see the students become aware that they are actually making a real difference to someone else, another community," shared Adam Brice, Assistant Principal of the school.

In order to effect change in another community, Ringwood North Primary organized the students into groups, where roles were divided up and solutions implemented. The collaborative nature of the project provided the opportunity for each student to share his or her particular talents and skills. This group dynamic, enhanced by readily available technology, including iPad devices, helped drive forward the challenge while keeping it exciting for the students. In traditional classroom situations, students do not get the same opportunities to switch gears and experiment with new roles.

"We are seeing an improvement in self-esteem and confidence, as our learners begin to experience more success with a medium which makes sense to them" said Brice. "We have promoted the notion that teachers are also learners, and as a result, we have our students willing to collaborate and share not only with one another, but their teachers. New ideas or learning are spread like wildfire and are celebrated during reflection."

What is also unique about Ringwood North Primary is that they embarked on a one-to-one learning trial in conjunction with their challenge based learning project — the group of 138 students had 24/7 access to iPad devices. Students took full advantage of this resource, setting up their own iTunes accounts and email accounts, as well as downloading helpful apps and videos. As such, iPad devices proved to be the key tool in their CBL activities, used for everything from research to communication to recording project reflections, which generally included creating movies and soundtracks. A combination of iMovie, Garageband, and ReelDirector made these movies come alive. Learning to use this vast assortment of tools and technologies afforded more opportunities for genuine critical thinking.

"The students are challenged to reflect upon their learning and revisit what worked, what didn't and why," Brice noted. "The notion that things don't always go according to plan has been celebrated and highlights the fact that there is always something we can learn from it."

Through these investigations, concepts have emerged which have allowed the teachers to seize new learning opportunities. From the ongoing development of news from newspapers to apps, to the exploration of hardship and its ability to be measured, students at Ringwood North Primary are directing and contributing to their own learning.

"We have students moving in and out of spaces and utilizing different learning areas as they need to," said Brice. "We just found that they've become more independent. They're really articulate." Solutions that the students brought to life included a bake sale to raise money to send stacks of books to a school library in Queensland to replace those damaged in the flood.

Other students have channeled their natural creativity to write a *Book Of Hope,* a collection of artwork and messages of support for the disaster victims. Tree plantings, concerts and donations to a Royal Society for the Prevention of Cruelty to Animals in Queensland were just some of the other solutions implemented by Ringwood North students. The overall sentiment of the participating students was a newfound feeling of making a real-world impact. "It's going great," one student shared. "It's a lot of fun, and without really knowing, we are learning!"

The educators at Ringwood North Primary have noted an improvement in student engagement, and not just in those children who typically perform best on standard tests or most easily comprehend lessons. "There are a lot of students who have really stepped up and demonstrated outstanding leadership skills," Brice revealed.

In addition to the students' positive responses to CBL for group interactions, the teachers are experiencing firsthand how new approaches to learning can transform student-teacher relationships. "There are a lot more quality opportunities for giving explicit feedback, whether that be individually or in small groups," said Brice. "We're finding that we've got the chance to really sit down with them and question what they're doing, have our students justify the decisions they're making and to elaborate on what they've already done."

Ocoee Middle School

Ocoee, Florida

Big Idea: *Politics*

Question: *What role do politicians play in everyday life?*

Challenge: *Actively participate in the political process*

Overview: *43.2 percent of Americans of voting age did not vote in the last election. With approximately half of US citizens not engaging in the political process, how then, can we not expect students to do the same? This challenge is designed to open students' eyes to the workings of state and local government and to show them that they can make a difference in society, even if they are not old enough to vote.*

Technology: *Ocoee is a one-to-one MacBook school during the school day; kids also used iPad and iPod touch devices*

The challenge that Ocoee Middle School undertook — "Actively participate in the political process" — is inherently complex because the participating students are all under the voting age. However, the exercise itself has provided the children a window into a process to which they will ultimately have the democratic right and social responsibility to contribute. To add another dimension, Ocoee is one of the first middle schools to join the challenge based learning study, offering a snapshot of how this learning approach works in a different age group, specifically 12 to 14 year-olds.

Among the goals the school set out to accomplish was strengthening group dynamics and communication skills. "We are absolutely thrilled with exactly the point of [CBL], which is the kids are working in groups," said Sharyn C. Gabriel, the principal at Ocoee Middle School. "They're doing authentic research. They're pushing themselves. They're coming up with creative solutions. It's an amazing process to watch." The combination of working in teams and utilizing emerging technologies provides the students with more real-world experience — a well-received departure from previous lesson plans focused on the same subject. "I have 12 and 13 year-olds interacting with senators and congressmen and going to commission meetings, whereas it used to be 'what are the three branches of government?'" Gabriel added.

The students are equally interested in this change in pace and teaching. "[CBL] explains it clearer than doing worksheets and other things," shared one student. While there was a definite enthusiasm for trying something new, staying on task proved to be an obstacle for the participants, in most cases due to conflicts that arose amidst the small, teacher-selected groups.

Feelings of success varied from group to group, revealing that challenge based learning may have a significantly different impact when the groups — like the challenges and solutions themselves — are entirely student-directed. Pre-set groups may be more appropriate for the elementary school set, who still rely heavily on teachers to help develop and navigate the social interactions of the classroom. Middle school is generally a time when kids are more assertive in building their social identities, and more cliques emerge.

"… It's hard to keep track of what everyone is doing and people always do what other people do …." said a student describing a challenge.

Students were mixed on the value of group work. "I would prefer if we got to choose our own groups," one student offered. Others took the opposite view, "Challenge based learning is a great way to communicate with each other. Four brains work better together than one. It's like a way to show/tell your opinion about that specific project," said another student.

Teachers at Ocoee also encountered some initial issues with students not fully grasping the meaning of the challenge. "The election process and political process are virtually synonymous with each other," said one teacher. "I don't think our 7th graders have been picking up on that." In order to circumvent this roadblock, the teachers worked together to create visual activities to connect both processes. "After that, the students seem to be more clear on the concept," the teacher confirmed. Though challenge based learning is student-centered, it has proved critical for teachers to selectively intervene and guide the students.

When it came to student engagement at an individual level, there was a more evenly dispersed sense of accomplishment that struck the educators at Ocoee. "You'd be surprised at those kids that are traditionally not successful, how good they are at presenting and how creative they are," Gabriel said. "We've had kids — and these are not your straight-A kind of kids — who are busting out the roof with test scores." This observation echoes the results of the challenge based learning pilot study, which conveyed stronger performances among more at-risk students.

The technology deployed in Ocoee's CBL project contributed to this student engagement. While facilitating one-to-one learning is not the norm for the school, they used a one-to-one approach for their project to create what Gabriel called "flexible digital learning environments." Each team of students had access during the school day to 30 desktop computers and a cart of MacBook computers, and iPod and iPad touch devices. Journaling and podcasting took place primarily on MacBook computers, and students used iPad devices to research everything they could about their local government, current laws, and commissioners' meetings. "The gamut ran from activities as simple as letter writing to creating Facebook pages for social awareness," Gabriel shared.

Accompanied by exploring new ways to use the available technologies, the students did work that is inherently difficult for their ages. In addition to attending government commission meetings, the students researched recently introduced local and state bills. To relate more authentically to the material, the challenge emphasized children having a voice in specific areas in which they are familiar, such as parks and libraries. Perhaps most importantly, the students found that the newfound knowledge and skills may stick with them as they continue their education after Ocoee Middle School. "The CBL thing is very challenging," one student admitted. "But, I got the hang of it and learned a lot about it. Challenge based learning can also help you when you get to high school."

Westside High School
Omaha, Nebraska

Big Idea: *Family*

Question: *What are the factors that affect families and impact their day-to-day activities?*

Challenge: *Improve Family Dynamics*

Overview: *Students at Westside High School in Omaha, Nebraska feel that families are the foundation of all societies. However, we feel that family relationships have deteriorated over time and are in a crisis. We challenge you to improve family dynamics.*

Technology: *Westside is a one-to-one MacBook school, and used GarageBand and iMovie extensively*

Challenge based learning provides students with opportunities to make positive impacts on their surrounding communities. Westside High School's challenge — "Improve Family Dynamics" — incorporated a different kind of community than other schools, but family relationships are arguably the most important driving factor in shaping peoples' outlooks and actions. Exploring their experiences with this type of project sheds light on how well challenge based learning translates to more immediate, personal communities.

At Westside, the students assumed a lot of control over the project, which proved surprising and refreshing for the participating faculty. "I think the biggest change over the last couple years has just been the mindset of trusting the kids and giving them the freedom to take the project how they want to a certain extent," shared Nathan Moseley, a 10th grade teacher. "There's a lot more freedom involved for them and they're in charge of their own learning in a lot of ways. So, the biggest change for me as a teacher is just letting go and letting them take control of that."

With this increase in freedom came more personal accountability for the students, and the groups they formed embodied this new sense of responsibility. "I usually do not like working in groups at all; I usually end up doing all of the work and get frustrated," revealed one student. "CBL was the best group experience that I've ever had. My group members were my friends and we all can count on each other. The work got done and people completed their portion of the project, which was very nice."

Many students echoed this sentiment, emphasizing how the positive group dynamics contributed to the overall success of the solutions they implemented together — even though some of the work was accomplished individually. "We all attended the support group, obviously, to do a test run of the support group," said another student. "We also all attended the interviews we conducted. Each of us wanted to be there for important parts of this project."

Together, students brainstormed and executed on solutions that they felt made a direct impact on family relationships in Omaha, including conducting support groups for children with divorced parents. Some students even stepped up to create keynote speeches for presentations about their challenge to other students, teachers, and a judging board, which is not something students typically experience before entering higher education institutions. "I feel I am making a difference because of this project in our community," one student shared. "We are going through with our solution no matter if we win or not, so the kids in our group at Loveland will benefit from our solution." The feeling of making a difference proved to be the most effective motivation for the Westside students.

Moseley cited the use of technology as a large factor in the outcome. "We are a one-to-one school," he explained. "Students [were] allowed to take their computers home with them each day and this helped with the implementation of the project." With the school-issued MacBooks, students developed websites, edited photos, designed informative flyers, and created keynote presentations about their project. Students also used digital cameras and camcorders to shoot movies, returning back to the MacBook computers to edit the videos and soundtracks in iMovie and create soundtracks in GarageBand.

The departure from more conventional high school curriculum also incited enthusiastic responses and even fostered a transformation in many of the students' ambitions. "CBL is a definite contrast from the typical classroom atmosphere, but I like it," said one student. "It's much more laidback, making it easier to concentrate and work, and I like that it allows me to manage my own time and make my own decisions on what I will accomplish for the day." The real world skill of effective time management is an increasingly invaluable outcome of challenge based learning.

Teachers felt that the impact students made on family dynamics in their community — and on their own personal growth — happened because they were given the chance. Moseley noted, "I think the biggest thing is seeing examples of what students have done and the process they went through, as well as getting the opportunity to carry it out by themselves."

Miami University
Oxford, Ohio

Big Idea: *Learning*

Question: *How can undergraduate education be more relevant?*

Challenge: *Make undergraduate education relevant!*

Overview: *Design a more relevant undergraduate learning experience. Is the current structure of university education effective in creating active citizens prepared to solve the challenges of the 21st century? How can a university education, both inside and outside of the classroom, become more innovative, adaptive and transformative to develop student portfolios that contribute to society?*

Technology: *Miami University is a one-to-one student owned laptop school, with MacBook and MacBook Pro computers. Garage Band and iMovie were used extensively, along with Adobe InDesign and Illustrator.*

The challenge that Miami University chose — "Make undergraduate education relevant!" — correlates with the overarching philosophy of challenge based learning to create learning experiences that transcend the boundaries of current, traditional education. The opportunity to see how students closest to entering the real world embraced the project is extremely valuable insight for advancing CBL. At the same time, the participating students here can be perceived as at a disadvantage compared to other cases; the K-12 years are much more formative, whereas students in higher education may be too accustomed to specific methods of learning.

"At first the students seemed to be…floating a little," shared Professor Peg Faimon at the beginning of CBL implementation. "I think some of the students in this class that we're teaching are used to a little bit more of a free form approach, a little less structure, a little more self-initiative, but some of them aren't. So, I think they're starting to get their legs under them in terms of feeling like they have a little more personal

direction and ownership of the problem." As the project progressed, it became increasingly clear that positive group dynamics motivated everyone to succeed.

"I feel that each of us are positively benefiting the project," said one student. "There is no single strong leader at this point, and we switch off in that role. I am making a difference in the group based on my technological skills and ideas."

As an added dimension to the challenge, the participating students were a hybrid of both regular and honor students from different disciplines and backgrounds, though that did not prove to be a hindrance. "Everyone is participating in their own way," a student asserted. "We each bring something different to the table with our different background and talents." In general, the students took a research-intensive approach to solving the challenge, interviewing college graduates at various stages in their careers, deploying student and faculty surveys, and finding engaging activities at other universities — even those online. The understanding was that the necessary change could only take place once the students were truly engaged in learning other peoples' and institutions' educational goals, as well as their perceptions of their learning experiences.

Laying the groundwork for implementing solutions may not have posed too many roadblocks for the students, but implementing solutions proved to be more challenging. "We have generated a lot of good ideas," said a student. "However, it is difficult to feasibly implement many of these good ideas."

Perhaps one of the most important benefits was that the experience of challenge based learning itself countered some of the disenchantment of traditional learning. "I do enjoy working on projects because they are extremely fulfilling when you have a finished project or have accomplished a goal," one student opined. "The fact that they require a deliberate effort over a more extended period of time than studying a few days in advance for a test, I feel much more accomplished after putting in the large amount of effort. Working for an end result is something that really motivates me."

The use of 21st century tools helped maintain this level of engagement throughout the project. Students learned and utilized a wide variety of tools on MacBook and MacBook Pro computers, including iMovie, GarageBand, InDesign, and Illustrator. In using this technology, students experimented in creative ways. "Several of the teams created printed materials as part of the solutions to the challenge," Faimon recounted. "One team created a visual mapping system to show how liberal education classes relate to one another. Another team created a brochure that identified different aspects of the many student organizations on campus. Another team created a promo piece for the Career Services Office."

Recommendations

We have learned a lot about challenge based learning after two major studies. Dozens of schools, nearly 100 teachers, and thousands of students have tried the approach successfully. Along the way, we've documented the efficacy of challenge based learning in a wide variety of settings — and we've seen best practices emerge that are already beginning to inform new implementations of CBL. This section of our report extends the research findings into eight recommendations for practitioners.

- **Prepare teachers by introducing them to challenge based learning in a professional development or workshop setting.** Use this time to answer questions about the process, share examples from this implementation and similar projects, and help teachers understand their role, which may be very different from what they are used to doing. Set expectations about what teachers will do and what students will be asked to do so that students hear a clear, consistent message throughout the project from everyone involved. A full-scale offsite retreat is not necessary; the key components are a dedicated time and place, someone to explain the process and answer questions, a chance for teachers to express their concerns and be heard, and an opportunity for them to collaborate on designing the challenges. This workshop should not only focus on the conceptual aspects of CBL, but also give participants the chance to practice the basic skills and tools they will need to help their students get the most from the experience.
- **Provide teachers with basic training in video, audio, and image editing.** Communication in today's world takes many forms, and it is increasingly clear that teachers need to be fluent in digital media. A strong case can be made for the inclusion of basic skills training even while teachers are in pre-service training. An even stronger case can be made for ongoing professional development for teachers around new tools and techniques with digital media, but there is no question that teachers contemplating using CBL will need solid basic understanding of how video, audio and images are captured, edited, and used to convey information. Half of the teachers involved in the CBLi study listed video as their top professional development need, above challenge based learning itself.
- **Frame the challenge in ways that deeply involve the students, and make it real.** The process in which the challenge is framed is critical in engaging students. It must be meaningful, relevant to their lives, allow for a wide range of solutions, and perceived by students as capable (and worthy) of generating positive actions in response. It is crucial for the challenge to actually relate to the real world and for it to have an impact on the students' families, local communities, or school. Student comments indicate excitement and engagement around the idea of being able to personally have an impact, and a majority of students both anticipated that they would be able to make a difference and

felt that they had afterward. It is also important that the size of the challenge is in line with the time and resources available for the project; if the challenge is too big, kids do not know where to start. The teacher's guidance is extremely important both in selecting appropriate challenges and in framing them in such a way that students can get their arms around what is being asked of them.

- **Allow teachers planning and preparation time, and ensure students have enough time to complete a meaningful solution.** The critical issues around time are to allocate it in proportion to the scope of the challenge, and to help students break down the overall project into reasonable segments. Enough time must be allowed for students to work through the big idea and brainstorm research questions, but there is a point of diminishing returns when brainstorming must end and research must begin. Likewise, students need plenty of time to do the research and brainstorm solutions, but then they must stop brainstorming and select one solution to develop. Finally, they need time to actualize their solution and to put it into practice. These points in the project are difficult for students to recognize, particularly if they are new to challenge based learning. Teachers must design the experience so that students understand how to move on at the right points.
- **Ensure students have the opportunity to act on their solutions.** The kind of learning that takes place in challenge based projects is reinforced by action, and students will learn much from the implementation of their own ideas. Part of the attraction of the projects to the students was the opportunity to persuade their peers and the adults in their life to take part in the activities they designed. In order for students to see that they can make a difference, they must be allowed to carry their solutions through to action. Implementation is accompanied by major outcomes in terms of the acquisition of 21st Century Skills such as communication, leadership, civic literacy, and social responsibility among many others.
- **Form workgroups with an eye toward the realities of group dynamics.** The number one issue with kids related to CBL, especially in grades seven to 10, is the composition of workgroups. Students want to be in groups that they perceive will be able to do a good job. An aspect of this is related to a core strength of challenge based learning — it provides a way for young people to engage with an idea they see as important to their lives. A natural and desired result is that they will be motivated to do their best work, and that motivation plays into why many students want a hand in group selection. At the same time, teachers should not give away the process of group formation. The key is to ensure that the assignment of students to groups is aligned in support of the group activities. Some conflict is a good thing when students are able to work past it, but more research is needed into effective ways to reduce friction within student workgroups.
- **Build 21st Century Skills into the project right from the start.** While nearly every skill identified by the Partnership for 21st Century Skills emerged naturally from the types of activities students engaged in as they worked on the challenges, it would be very easy to include them all. Teachers who are aware of the list of skills can incorporate specific project components to build on them. Skills such as financial and economic literacy are a natural fit for challenges related to the economy, but almost any topic could have a financial component. Teachers can plan final project requirements that incorporate subsets of the 21st Century Skills, or encourage exploration and research that helps students develop certain skills.

- **Practice, iterate, and improve the process.** It is a natural and predicable response for teachers to have some uncertainty at the outset of their first CBL project, but as this study shows, the vast majority of teachers are easily able to learn and implement CBL. Common sense would support the notion that the second and third times they implement a CBL project will be much smoother than the first one, and that skills developed along the way will not take time away from other tasks once learned. A common reflection heard at both the pilot and the CBLi workshops was that teachers were excited, but also a bit apprehensive about giving up control, worried that students would not pick up the reins and do the work. Students, too, tend to be nervous at the start; they were not sure how to act in a situation where they directed their own learning. Nonetheless, by the end of their projects, those concerns had virtually evaporated.

We began this report with the observation that the children in our schools today will inherit unprecedented problems that will need to be addressed in their lifetimes. We know that decades of reform have not given us hope that the erosion of skills in our youth will subside.

We know new ideas are needed — and challenge based learning is an effective one.

Fresh, new, relevant to today's issues, it is an approach that has been shown to effectively engage students at all levels of learning. The findings of the Challenge Based Learning Implementation Study are clear, and they are encouraging. They validate the findings of the pilot study, and solidly support further experimentation, further research, and further work in the field around robust new ideas.

More than that, these findings show that there is a better way to reach young people and engage them around important issues. We know we need to make learning relevant to the challenges youth will face in their lifetimes — and we know we can. Challenge based learning is a framework we can put into place today. Rich in activities that promote 21st Century Skills and rich in avenues for kids to direct their own learning and help their communities at the same time, challenge based learning is also scalable and easy for teachers to learn. It engages young people at every grade level, across a wide range of disciplines.

It is an idea whose time is now.

Methodology

The evaluation process drew on the principles of outcomes-based evaluation; various activities of the project were monitored via indicators to help the evaluators judge whether the project was unfolding as planned, or if adjustments were needed. Each activity was presumed to have needed inputs and expected outputs that would influence subsequent activities as part of a critical path. Taken as a whole, the activities of the project were presumed to have a causative relationship with the key outcomes of the project.

A combination of surveys, interviews, and background research, each keyed to the timing of the project itself, provided the data needed to monitor and analyze the project as it unfolded, as well as to document the overall outcomes across the study. All participating students (n=1203) and teachers (n=62) were asked to complete pre- and post-surveys that among other research aims, were used to determine changes in perspectives or behaviors. A random sample of teachers was chosen, and each were interviewed at approximately the midpoint of the project; similarly, students were asked to respond to a set of open-ended questions at the approximate midpoint. A separate instrument for teachers focused expressly on the group selection process in each class-level project, with the goal of providing insight into the relationship between group assignments and groups that produce successful projects.

The evaluation plan, developed by the NMC with assistance from an advisory group of educational researchers, is based on an open data model; the evaluation design, the instrumentation developed, and all of the data produced in the study will be made available to other researchers who may wish to mine it for additional materials.

Summative Assessment Model

The pilot study identified ten major outcomes that spanned overall class outcomes; changes in teacher perspectives; and changes in student behaviors and perspectives; the summative outcomes of this project are hypothesized to be similar, based on those findings, and are cast here as expected outcomes. The ten expected outcomes, five focused on students, and five related to teachers, were:

THE TEACHER EXPERIENCE	THE STUDENT EXPERIENCE
• Teachers will report that overall engagement of all students in the class increased • Teachers will report that students master the expected material across the class • Teachers will feel that their training and support allowed them to be successful • Teachers will report that they intend to use CBL again • Teachers will report that CBL is a good use of class time and resources	• Student self-reported learning will align with the 21st Century Skills framework • Students will report that their own work mattered in achieving the project outcome • Students will report that the project was relevant • Students will spend more time on task • Student attendance will improve

The summative assessment also included measures intended to provide ways to gauge the success of the CBL implementations. The notion of what constitutes a successful foray into the world of challenge based learning is complex, with important outcomes for the community, the school, the teacher, and most critically, the student.

Among the dimensions of success that interested us was how CBL fit with the school climate. Did it help the school accomplish its overall targets for the year? Did the approach work well for the teacher, and did it help convey the required curricula? Did it help to focus student interest, and increase motivation? Did students do the required work? Ultimately, these questions are all subservient to the most important one — did the students learn? What, and how well?

Formative Assessment Model

The formative assessment focused on three major phases of the project. The first was the teacher-training workshop that was held in Dallas. There are two possible outcomes for this activity, expressed at the simplest level — teachers either felt ready to implement their projects, or they did not. A number of concerns were anticipated based on the results of the pilot; these were assessed in the pre-project survey to be administered at the end of the workshop. This list is not complete, but among the variables to be monitored in Dallas were:

- Computer skills of the teacher
- Experience as a teacher
- Understanding of CBL
- Understanding of group dynamics
- Worries about time away from other tasks
- Confusion with similarly named approaches
- Uncertainty around on-campus support

The second critical phase of the project was the time period on campus when the project was being introduced and planned with students. Two key factors were monitored here. The first was the open-ended time when the kids brainstormed what they may do to address the "big idea." In the pilot, although it was not clearly established, it seemed intuitively obvious that if a class flounders at this key point, critical time may be lost that would be better spent on implementing the solution. An evaluation goal was to ensure that teachers understand how important it is to balance a wide-ranging exploration of ideas with the need to move to a focused solution that will drive the rest of the project. A second constraint that can impact the success of the project is a teacher's need to control students' choices for what they will do.

The third key phase was the on-campus implementation itself, which for the purposes of the evaluation started at the point the student solution is identified. This is when students began to work on the various tasks related to the solution. It is as this point that the political dimensions of the classroom are thought to be most influential on the overall engagement of the class. By asking teachers to reflect on the social graph of the class at this point, it was hypothesized that their choices for assigning groups might be influenced to include social and political dimensions in their choices. A "panic button" process was established so that teachers who found themselves in need of help at this (or any stage) could call on a group of mentors to assist them in their thinking.

Research Component

The CBL Research Advisory Group suggested four additional areas in which to conduct investigations. Questions designed to elicit useful data were included in the instrumentation prepared for the evaluation, thus extending the work in ways that will add to what we know about how CBL works and how it may impact the learning environment.

Training and Development. While some training was provided for participants, this dimension of the study was more aimed at understanding the previous preparations and experiences teachers have had. In particular, the correlation between training and experience was a focus. A related dimension was to better understand what aspects of a teacher's training and development were perceived as most critical, and what pieces they felt were missing from that preparation that might have been helpful. Questions were carefully designed to remove any technological bias so that aspects related to non-technical dimensions of preparation might surface.

Place and Time Changes. This dimension focused on understanding where students were doing the work required for CBL. Did this approach extend learning beyond the school day? Where did the work take place? Did students work at home or other non-school locations? Did their work extend to their social networks? These questions were incorporated into the mid-point and post student surveys.

Group Dynamics. How did the way students worked with each other in groups impact the outcomes of their projects, if at all? Were there any surprises teachers noticed? What were they? Such questions were included in the midterm teacher interviews, and teacher post interviews. A set of validating questions was included in the student post survey as well. A special instrument focused on the role of group dynamics in the teacher's selection of groups and was be compared to the outcomes for each group to see what kind of relationship existed between them.

Skills and Resources. Related to the dimension around training and development in some ways, this dimension focused more on the key skills needed in general to successfully implement a CBL project in a classroom, as well as the human and physical resources (tech support, access to video equipment and software, etc.) required.

Instrumentation and Data Collection

Four online surveys and two interview/narrative protocols were designed, along with a third protocol for eliciting the data on group selection. Additionally, secondary research documented school characteristics and demographics of the 19 participating institutions, using data from NCES23 and other sources.

Student Surveys and Reports. All students were asked to complete an online survey as the project began and again as it ended. The primary (but not exclusive) purpose of the surveys was to determine changes in student behavior or perspectives related to the following areas of interest:

- Time required (spent) on the project in and out of school time
- Places where the work will be (was) done
- Were family, friends, or other members of the student's social network outside school involved?
- Ability to influence the work and its outcomes
- Assessment of how the work will be (was) done in groups (eg, did all students participate?)

- Student affinity toward project-oriented schoolwork
- Student affinity toward working in groups
- The degree to which student learning aligned with 21st Century Skills
- Group dynamics — who were the idea people? Who went the extra mile? Were these easy to predict?

A mid-project random sample of students was asked to contribute a written narrative of their experience in response to a set of prompts as a way to validate the survey responses.

Teacher Surveys and Interviews. All teachers completed an online survey as the project began and again as it ended. The primary (but not exclusive) purpose of the surveys was to determine changes in teacher expectations or perspectives related to the following areas of interest:

- Time required (spent) on the project in and out of school time (before/after)
- Skills they perceived to be critical in implementing CBL (before/after)
- Equipment and other resources required by the teacher (before/after)
- Equipment and other resources required by students (before/after)
- Student skills critical to completing a successful project (before/after)
- The value of their past professional development for CBL (before/after)
- What was missing from their past professional development vis-a-vis CBL (before/after)
- Their top three concerns (going in, and in retrospect)
- Their top three challenges they expect to (did) face implementing CBL
- The degree to which they will be (were) supported on campus
- The degree to which they will be (were) supported by the CBL community
- How hard will it be (was it) to implement CBL
- What were the most important roles they played as they used CBL

A mid-project random sample of teachers was interviewed based on a set of prompts as a way to validate the survey responses, as well as to surface any surprises they might have been noticing in the ways students were engaging in the material, the process, and with each other. Teachers were also asked to submit a short report assessing the social graph of their class via a narrative about two-thirds of the way through the project.

Video Interviews. While video interviews were not part of the formal evaluation, they were part of the overall communications effort and all relevant video interviews from the project were available to the evaluation team. These videos were examined for additional insights from teacher and/or student commentaries, and used as appropriate.

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CPS iPad Program 2011

Program Impact and Reflections

Program Background

The SY2010-11 iPad grant opportunity, spearheaded by the Education Technology Department of Chicago Public Schools, was funded by the federal Title IID grant. Schools receiving the grants were awarded up to 32 iPads, one MacBook, one storage cart, volume purchasing vouchers, and ongoing professional development. A total of 23 schools were awarded the grants for a total spending of $450K.

iPad classrooms ranged in grade level from early elementary to high school, and were equally diverse in their content area, proportion of students designated as ELL or Special Needs, proportion of low-income students, and neighborhoods. Roughly 50 teachers and over 1700 students gained access to iPad technology through the grant. The original iPad objectives developed by Education Technology are outlined in the sidebar.

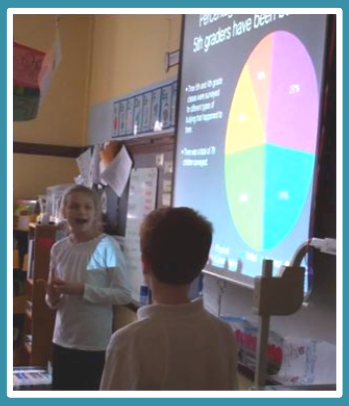
Stakeholder Collaboration

A collaborative and dynamic partnership between educators involved in the iPad grant, CPS's Education Technology department, and staff and trainers from local Apple offices led to the creation of a professional learning community throughout the school year through a series of trainings led by Apple and CPS trainers as well as a collaborative online hub for the CPS iPad project.

Representatives from Curriculum and Instruction also engaged in the project, a relationship both departments have further codified for the initiative's SY2012 iteration. While parents were not directly involved under the auspices of central office, educators included parents in their children's iPad-based learning.

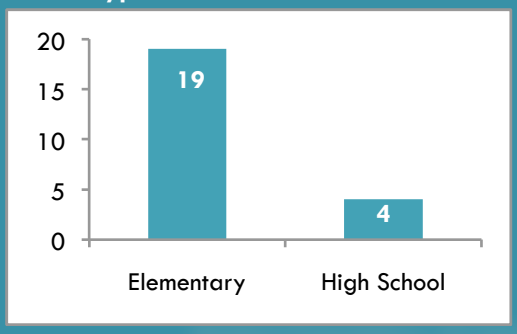
iPad Grant Objectives

1. Increase academic achievement by enhancing student performance.
2. Create and support equitable opportunities for student learning through technology.
3. Increase competence and confidence in technology.
4. Define a district model to increase student achievement through technology.

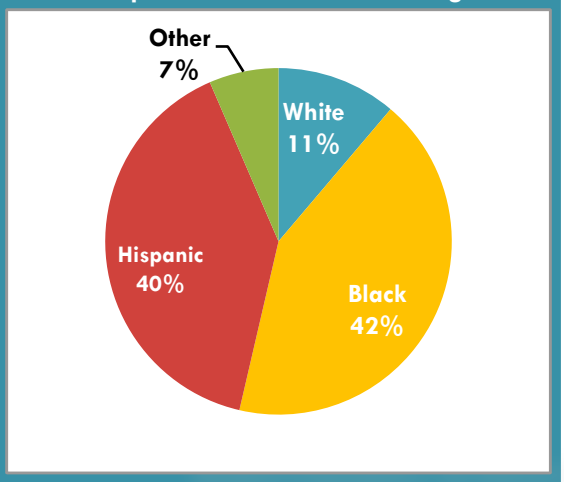


iPad School Demographics SY2010-11

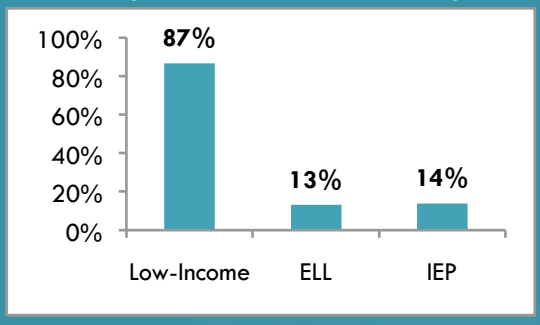
School Type of 23 Schools



Student Population: 23 School Averages



Student Population: 23 School Averages



Source: 2010 Illinois School Report Cards. "Other" includes Asian/Pacific Islander, Native American, and Multiracial/Ethnic categories.

Selection Process

iPad School Grant proposals solicited through CPS communications were then evaluated by Education Technology on a multi-tier rubric addressing (a) the grant plan's overall quality; (b) the grant-writer's ability to independently assess and monitor grant success and alignment to curricular goals; (c) the plan's alignment to existing standards; and (d) the feasibility and quality of proposed plans for collaboration and creation of an inclusive, continuously improving learning community. This competitive process ensured that the proposals were transformational and that our teachers had a solid foundation for how to use the technology prior to receiving.

Participating Schools' Demographics

Schools were not chosen on basis of grade level, location, or their students' overall demographic information. However, demographic information on the students within iPad schools was collected and is presented in the sidebar to the left.

Data Collection Methodology

Program effectiveness was monitored continuously throughout the school year through classroom observations and artifact collection.

A more robust data analysis occurred through a synthesis of end-of year survey data from teachers and students, electronically submitted anecdotal evidence and artifacts, in-depth interviews with twenty-two teachers, and an internal analysis of benchmark test data.

Data Overview & Conclusions

Teacher & Student Survey Results

Of the forty-four teachers surveyed, results indicated increased capacity in instruction, student engagement, and student learning within iPad classrooms. Instructionally, 96% of iPad teachers strongly agreed or agreed that using iPads helped increase the overall quality of instructional strategy and methods. Eighty-seven percent strongly agreed or agreed that using

iPads helped increase the quality and frequency of teacher feedback, and 99% strongly agreed or agreed that using iPads helped the quality and frequency of differentiated materials and lessons.

In terms of student engagement, 82% of iPad teachers strongly agreed or agreed that using iPads helped increase student engagement, including increased completion of homework, increased time on task, and heightened motivation and confidence. Ninety-two percent of iPad teachers strongly agreed or agreed that using iPads helped increase students' 21st century skills, and 87% strongly agreed or agreed that using iPads helped increase the frequency and quality of student-created materials.

Academically, 76% of iPad teachers strongly agreed or agreed that using iPads helped increase student's academic achievement. Seventy-five percent strongly agreed or agreed that using iPads helped increase reading fluency, and 77% strongly agreed or agreed that using iPads helped increase performance on formative and summative assessments.

Additionally, students were surveyed at the end of the 2011 academic year. Of the 1,141 student respondents, 90% strongly agreed or agreed that iPads make school more interesting or enjoyable, 94% strongly agreed or agreed that iPads improved internet research, and 90% strongly agreed or agreed that iPads make them feel more confident about school and lessons learned.

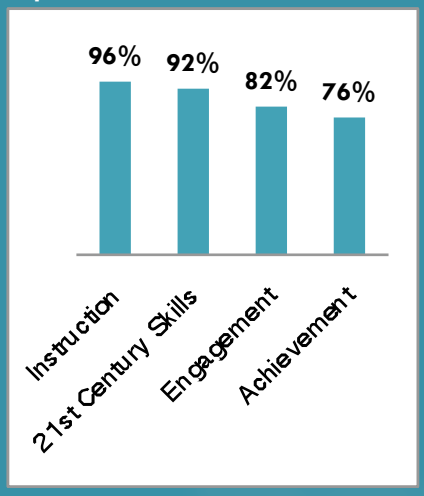
Quantitative Test Data Analysis

Both Scantron and NWEA test data were analyzed for the teachers of iPad classrooms where applicable. Of the twenty-three schools granted iPads, ten gave students the Scantron test and four gave students the NWEA in the 2011 school year. Based on Scantron results, it appears that participating schools scored higher in math and reading compared to the district average. One point that did stand out is the majority of students made significant increases in their math scores across the three administrations of the Scantron test during the 2011 school year. NWEA test results suggest that fifth through eighth grade iPad classrooms made the most significant increase in reading and math, compared to first through fourth grade iPad classrooms, and in some cases out performed the district average by 29%.

NOTE: Results are not based on a scientific study, as control groups were not involved in the data collection.

Teacher Survey Results

Self-Reported iPad Classroom Improvements



Percentage of teachers who strongly agree or agree that iPads helped improve each respective dimension.

Qualitative Analysis

Trends from in-depth interviews of twenty-two teachers not only further supported survey and anecdotal data but also provided information and suggestions for future training, professional development, and program evaluation, each of which is discussed further in *Reflections and Next Steps*.

Instructionally, teachers were able to enhance their ability to provide data-driven instruction and continuous feedback to their students once iPads were introduced. Applications such as Dropbox, Google Docs, and corresponding grading software allowed real time access to student performance data and cloud-based capabilities of returning feedback and comments.

> "Never have I seen a device that can compete with video games and television. When given the choice to watch a movie or do a keynote presentation, my students chose the keynote presentation."
> *-Quan Le, Goudy Elementary*

Cloud-based storage and organization of documents also enhanced a teachers' ability to manage and distribute differentiated instructional materials and, at times, mini-lesson videos recorded by either the teacher or third party instructional app or site developers such as those at Kahn Academy. Device uniformity in appearance also further assisted differentiation by removing the potential for student-to-student stigmatization based on visually different material.

Beyond the expected increase in technical literacy they lent, iPads also challenged students to become more critical and innovative thinkers, often in collaboration with others. Collaborative social networks developed for classroom use, such as Edmodo, coupled with cloud-based document creation and modification increased both the ability and the willingness of students to involve peers in their learning.

Collaboration, discussion, and feedback amongst students often occurred beyond required amount with little or no teacher directive, something teachers noted as both rare and logistically difficult in pre-iPad classrooms. Students were also able to more readily create documents or presentations that synthesized their learning and modify them continuously rather than stopping revision and modification with a hard copy document.

Teachers also noted the device's highly tactile and interactive manipulation, user-friendly control and organizational capabilities, and text-to-speech and other audio capabilities as developmentally appropriate for lower elementary students, students with special needs, and English Language Learners.

Reflections and Next Steps

Nationwide, other districts have yet to pilot a program of this scale with iPads: New Jersey's Edison Township School district is currently piloting an iPad-based Algebra I curriculum, four districts (deemed "divisions") in Virginia recently introduced an eBook on iPad initiative with a little over three hundred students, and a high school in Florida's Lake County will be granting iPads to each of its nearly two thousand students. While similar initiatives have and are continuing to appear around the country, the partnership between Apple and CPS, which will impact over 4,500 students in the 2012 school year, is unparalleled.

This endows CPS's Education Technology department with both the opportunity and the responsibility to strategically improve and share lessons learned from each iteration of its iPad grant cycle. Professional development, collaboration and sharing of best practices, and the system of evaluation and corresponding metrics have been restructured for the second iteration of the grant cycle in ways that reflect findings from

the 2011 school year, are malleable enough to respond to continuous feedback throughout the year, and are forward-looking in order to inform future program expansion.

More Rigorous Evaluation

Data, both qualitative and quantitative, suggests tangible opportunity for transformative effects in teaching and learning with the integration of iPads in a wide variety of classrooms. The SY2012 evaluation system more comprehensively measures the effect of iPads in major impact areas highlighted by SY2010-11 iPad educators, as well as those areas of opportunity highlighted by industry reports[1]. The revamped data collection system is intended to compare longitudinal progress on a variety of dimensions between iPad teachers and non-iPad classrooms, define areas of opportunity that iPads most effectively impact, and is developed in accordance to best practices highlighted by the Foundation Strategy Group (FSG) and the Skoll Foundation's 2005 *Measuring Innovation: Evaluation in the field of Social Entrepreneurship* as well as FSG and the W.K. Kellogg Foundation's *Exploring Options: Communicating Education Metrics*.

iPad Grant Evaluation Dimensions: SY2012

Impact on Instruction
- Data Driven Instruction & Feedback
- Differentiation
- ELL & SPED Modifications
- Parental Involvement & Engagement

Impact on Achievement
- Overall Academic Performance and Achievement
- Grant Application Project Impact
- Engagement & Participation

Impact on 21st Century Skills
- Critical Thinking
- Innovation
- Collaboration
- Creation

Increased Strategic Collaboration

The "iPads in Chicago Public Schools" blog (http://ipadsincps.blogspot.com) is intended to further the opportunity for and ease of collaboration amongst iPad teachers and school leaders beyond the scope of formal training and professional development. This coupled with the introduction of critical friends is intended to catalyze professional learning communities to codify beyond the nascent stages they reached in SY2010-11.

Members of CPS's Curriculum and Instruction department have also been increasingly involved as partners of Education Technology, collaborating on the transformation of existing learning materials and instructional best practices to iPads to not only substitute the iPad for hard copy as a material platform, but to enhance the learning potential of existing curriculum with the integration of the device.

> "[No other grants] have ever even come close to level of support that this grant has provided, and that's why it's been the most successful grant I've ever received. When else do you ever see a group of teachers begging to go to PD?"
> *-Jennie Cho Magiera, National Teachers Academy*

Both pilot and long term partnerships with textbook and instructional materials companies and supplementary e-learning organizations is also being explored collaboratively by both Education Technology and Curriculum and Instruction, with the end goal of employing limited instructional material funding in its most high-impact capacity.

[1] These reports include the OECD's 2011 *PISA 2009 Results: Students On Line: Digital Technologies and Performance*, The New Media Consortium and Educause Learning Initiative's 2010 *Horizon Report*, and the Consortium on Chicago School Research's 2002 *Educational Technology: Availability and Use in Chicago's Public Schools*.

Conclusion

iPads have proven effective at increasing student achievement and instructional capacity on a variety of dimensions, and the coming school year's new evaluation system will provide more robust data and evidence supporting the impact of the devices.

Subsequent strategy of the initiative is intent upon defining how the devices can most effectively assist the district in its larger goals of decreasing the gaps currently existing in student achievement given its limited budget and resources. Discussion here is already underway with both Curriculum and Instruction and Education Technology, and will continue throughout the coming school year.

Technology Profile			
Each Site completes a Technology Profile to provide baseline data on teacher knowledge, skill and current use of technology. A follow-up Technology Profile will be done at the end of the school year to measure teacher growth in use of technology in teaching and learning and decide lessons learned and next steps.			
LEADERSHIP PROFESSIONAL DEVELOPMENT			
Focus of Professional Development	**Audience**	**Modules**	**Time**
Leadership training to support technology initiative. Topics of focus for consideration: • Rational for change • Shared Vision • Action Planning • Measuring success	Principal and 2 - lead teachers from each school.	2 each of 3 hour modules	November
Leadership training to support technology initiative. Topics of focus for consideration: • Challenges and Successes • Communication • Support strategies • Modifications to plan • Lessons learned	Principal and 2 -3 lead teachers from the school	2 each of 3 hour modules	January 2012 March 2012
TEACHER PROFESSIONAL DEVELOPMENT – Phase1 Schools			
Focus of Professional Development	**Audience**	**Modules**	**Time**
Introduction to the MacBook and iPad **Module***1:* • Intro to the MacBook OSX, iLife iPhoto. Sharing content ***Module 2 :*** • Creating digital content • Create a podcast with GarageBand • Technology/curriculum infusion • Sharing content ***Module 3:*** • Intro to the iPad • Native apps, free apps etc. • Sharing content ***Module 4*** • iWork on the MacBook and iPad and technology curriculum infusion strategies • Sharing content	All teachers that are part of the phase 1 schools	8 modules on site for each school. Each module is 3 hours	ASAP
TEACHER PROFESSIONAL DEVELOPMENT – MIDDLE/HIGH SCHOOL TEACHERS (PD/School)			
Focus of Professional Development	**Audience**	**Modules**	**Time**
Focus PD for the MacBook and iPad • MacBook/iPad in science • MacBook/iPad in mathematics • MacBook/iPad in language arts • MacBook/iPd in social studies • MacBook in Special Education	Subject specific teachers	10 Modules per school site	ASAP
In-Class Coaching and Mentoring Ensuing component of the strategic plan and Basic literacy are being met.	Subject specific teachers	10 Modules	2 -3 weeks after previous Focus session.