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Thin-clients in the Classroom; Software Compatibility and a Survey of Systems

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Abstract: Thin-client computing devices have several advantages over traditional networked PCs in an academic classroom environment. The most significant of these are lower cost, ease of maintenance and administration, lower power requirements and increased reliability. This study examined a variety of Windows applications being used in the Graduate School of Business and Public Policy at the Naval Postgraduate School. The majority of the programs were found to be compatible with the thin-client architecture. The study also found there are a wide variety of thin client devices on the market and it is important to test prospective devices to determine whether they satisfy all of the user's functional requirements.

Introduction

In 2004 the Graduate School of Business and Public Policy (GSBPP) at the Naval Postgraduate School built a prototype smart classroom seating 45 students with networked laptop PCs at every seat. Infusing computer technology into the traditional lecture based classroom proved to be a resounding success and that classroom quickly became the most frequently requested room every quarter. Faculty reported they could cover up to 20% more material in the same amount of time. The improved efficiency was the result of the instructor being able to optimize their instruction by using computer based tools whenever it was appropriate rather than having to wait for a specific hour of the week when they had access to a computer lab. In the past, courses would be divided between lecture based classroom time and one or two hours per week of computer lab. Research has also shown a significant increase in the level of student interaction when computer mediated communications are incorporated into the education process (Brinkley, 2003).

The success of the prototype project generated a demand to install computers for every student in as many classrooms as possible. Unfortunately for GSBPP and most other schools, the goal of procuring and maintaining enough computers to satisfy the demand is impractical due to limited resources. Not only is the procurement and life cycle replacement of conventional PCs too costly, the existing technical support staff could not handle the workload of maintaining a large number of additional computers. The need for a more cost effective alternative led to this study on Thin-client/Server Based Computing (TCSBC). The study is a multiphase project. This first phase focuses on the compatibility of thin-clients to support the school's installed base of Windows applications and provides a brief survey of different thin-client terminal options. The second phase will focus on performance issues as well as document lessons learned from the implementation and maintenance of a thin-client network.

Background

Computer technology has come full circle with the rebirth of thin-client computing. Thin-clients were in fact part of the original concept in computing with large mainframes servicing simple client terminals that provided users with nothing more than keyboard and monitor interfaces. The popularity of the desktop PC soared in the late 1980's and 1990's nearly erasing thin-client technology from the computer revolution. However the relatively short life cycle of the modern desktop PC, along with growing security and management concerns, is prompting many organizations to rethink their computing strategy. At the same time increased network bandwidths and advances in server based technologies have made TCSBC a viable option again. Today's thin-client devices continue to use a server-centric model where all of the data and applications are stored on the server. This differs from the networked

PC model where the data may be located on a network server but the applications are stored locally on the PC's hard drive.

Thin-client Advantages

Arguably the greatest advantage of thin-clients over traditional PCs is the lower total cost of ownership, which includes both the original acquisition cost and the life cycle maintenance and support costs. Thin-client acquisition costs are normally just 50-60 percent of a full workstation (Williams, 2005). Even greater savings will be realized by the reduction in support and maintenance costs. The Gartner Group (1999) reported thin-client desktops could cut support costs by 80 percent. Cost savings are not the only advantages of thin-client desktops. Williams (2005) and Romm (2006) cite the following additional benefits:

Longer Service life – With no moving parts and no built-in obsolescence, thin-clients may last up to ten years.

Reduced Power Consumption – With no need to power internal devices and fans, thin-clients consume only ten percent of the amount of electricity needed to run a PC.

Easier Configuration Management – Thanks to the server-centric environment, applications, updates, and security patches only have to be installed on the server vice individual PCs.

Improved Security – The server-centric environment eliminates the need to install anti-virus software on the client PCs and allows system administrators to focus their protection efforts on just the servers. Storing everything on the servers also allows for more efficient and comprehensive backup procedures since there is nothing to backup on the end user stations.

Reduced Space and Weight Requirements – Many thin-client terminals are about the same size and weight as a paperback book. This could be a significant benefit in space constrained environments.

Reduced Noise Pollution – With no fans or other moving parts, thin-client terminals produce virtually no noise at all. This could be an important consideration for classroom and library installations.

Inherent Theft Deterrence – Because the thin-client is useless without the server they are much less desirable to thieves than PCs and therefore less likely to be stolen.

Thin-Client Disadvantages

Though not as numerous as the list of advantages, thin-clients do have some negative aspects that must be considered. Perhaps the greatest of these stems from the same server-centric mode of operation that provides so many of the benefits. The server-centric architecture also means server-dependency. If the server itself goes down or network access to the server is interrupted, the thin-client station is rendered useless. In a networked PC environment users could continue to use those programs that were loaded on the local hard drives. Other disadvantages noted by the British Educational Communications and Technology Agency (Becta, 2004) include:

Reduced Software Compatibility – Some applications are not network compatible and will not function unless they can be loaded onto end user PC hard drives. Because these types of applications are incompatible with the thin-client environment, alternative applications may have to be identified and purchased.

Inflexibility – If a particular application or add on has not been installed on the server, it is not possible for a user to download it to the client machine. End users are totally reliant on server administrators for software installations and updates.

Higher Bandwidth Requirements – As thin-clients require nearly all processing to be carried out on the server, there is considerably more network traffic between the clients and the server. Inadequate bandwidth will result in poor performance for the end user.

Reduced Peripheral Options – Most new thin-client devices include USB ports but the end user is not able to add device drivers. Therefore while the thin-client station may recognize common peripherals such as flash drives and other plug and play devices, peripherals requiring a driver such as a printer or PDA would not be supported.

Poor Multimedia Performance – Recent advances in thin-client processing and server technology have helped alleviate this to some extent, however real time full motion video with sound continues to be problematic on a thin-client network.

Software Compatibility

The Naval Postgraduate School has often been described as a corporate university because of its emphasis on directly supporting the United States Navy (and other armed forces). In 1997 the Navy implemented its Information Technology for the 21st Century initiative which specified Microsoft Windows as the standard desktop PC operating system for all ships. Since that time most shore bases have also followed suite. Nearly 100 percent of the applications used by the GSBPP are Windows based. The first step in determining whether the thin-client architecture was a viable alternative for the GSBPP was to identify which of the existing applications were, and were not, compatible with that architecture. Table 1 identifies the applications tested, whether or not they were compatible, and comments (if applicable).

THIN-CLIENT SOFTWARE COMPATIBILITY TEST

Application	Compatible		Comments
	Yes	No	
ActivCard Gold		X	This application is used to support a smart card reader. That device is not supported by the thin-clients.
AdAware SE Personal	X		Yes for the server but N/A for the client stations.
Adobe Acrobat Reader v6.0	X		
ARC	X		
ArcGIS 9.1	X		
Arena v7.01.00	X		
Altova Authentic 2004	X		
Clementine v9.0	X		
Crystal Ball Pro 4.0		X	Requires local hard drive installation. Vendor states newer version is compatible with networks / thin-clients.
Data Analysis Plus 5.0	X		
Data v2.6	X		
DivX Player	X		
Eclipse 3.0		X	Difficulty installing appeared to be a JAVA issue.
EES - Engineering Equation Solver	X		
Excel Premium Solver 5.0	X		
FAST	X		
FireFox Internet Browser	X		
GAMS v21.3	X		
Genie 2.0	X		
Ghostsript v 8.51	X		
Internet Explorer v6.0	X		
Logical Decisions	X		
Macromeida Dreamweaver 8	X		
Management Scientist v5.0	X		
Maple rel 10.1	X		
MathType 5.2c	X		
MatLab 7.1	X		
Microsoft Access 2003	X		
Microsoft Excel 2003	X		
Microsoft Frontpage 2003	X		
Microsoft Image Composer	X		
Microsoft Outlook 2003	X		

Microsoft .NET Framework v1.1	X	
Microsoft PowerPoint 2003	X	
Microsoft Project 2003	X	
Microsoft Publisher 2003	X	
Microsoft Visio Pro 2003	X	
Microsoft Visual Studio 6.0	X	
Microsoft Web Publishing Wizard	X	
Minitab rel. 14.20	X	
MS Media Player 9.0	X	Some problems with full motion video.
Putty 0.57	X	
QuickTime	X	
Real Player	X	
Roxio Easy CD Creator 5.0	X	Used to burn CDs on the server.
SPSS 13.0	X	
STATA Software	X	
Symantec AntiVirus	X	Runs on and protects the server.
WinZip v8.1	X	

Table 1: Thin-client Software Compatibility Results

The findings of the compatibility test affirm that thin-clients can be used to run most applications that are “network friendly.”

A Survey of Thin-client Systems

The second objective of this phase of the research project was to examine a variety of different types of thin-client devices to identify which would be the most appropriate for our graduate school environment. To accomplish this a prototype thin-client network was established in a classroom laboratory. The lab was connected to the school’s backbone and each workstation had the same functionality it would have in a regular classroom. The same Microsoft Windows application server was used to test each thin-client device in order to ensure any differences noted in performance was directly attributable to the differences between the thin-clients. The specifications of the Windows server are listed in table 2.

Operating System	MS Windows Server 2003
Thin-Client Communication S/W	MS Terminal Server
Processors	Dual AMD Opteron 244
RAM	4GB DDR400
Primary Hard Drive	IDE SATA 78GB
Secondary Hard Drive	IDE SATA 300GB
Optical Disc	16X DVD-RW
Network Connectivity	10/100 Fast Ethernet

Table 2: Windows Server Specifications

Sun Microsystems Ultra Thin-client System

The first and most sophisticated thin-client system examined consisted of three Sun Ray 170 terminals and a Sun Fire V240 UltraSPARC server from Sun Microsystems (Fig. 1 and 2). The Sun Ray 170 terminal is an all-in-one device which includes a 17” LCD panel. The quality of the display is excellent and supports 24bit graphics using a resolution of 1280x1024@60Hz. The unique design of the base allows the monitor to be tilted in a variety of positions.

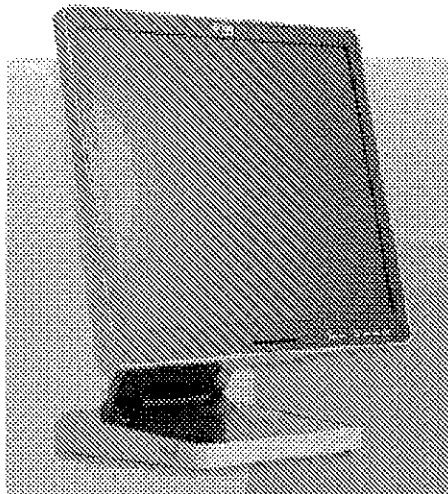


Figure 1: Sun Ray 170 Virtual Display Client

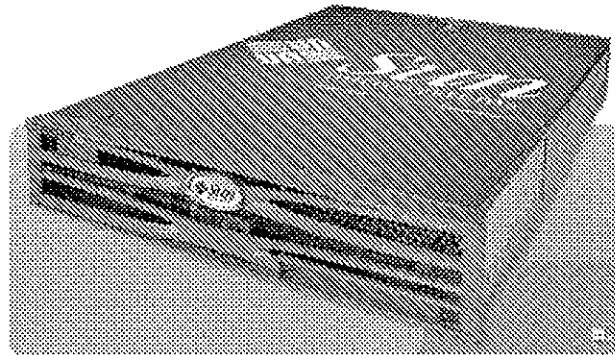


Figure 2: Sun Fire V240 UltraSPARC Server

The Sun Ray 170 is classified as an ultra thin-client because of its stateless design. While most thin-clients have a built in operating system such as Windows XPe, CEE, or Linux, the Sun Ray 170 downloads its operating system from the Sun Fire V240 server. The stateless operation allows for complete session mobility and helps ensure the protection of data. Sun is the leader in secure network design and the U.S. Navy recently chose the Sun Ray thin-client architecture to upgrade its 160-ship surface fleet (Weiss, 2005). The Sun Microsystems solution was the only thin-client alternative that required another server in addition to the MS Windows application server. The Sun Ray clients pulled their operating system from the Sun Fire V240 server and continued to use that server as their gateway to the MS Windows application server. The Sun Fire V240 server uses the Solaris operating system which is Unix based and therefore not able to run MS Windows programs directly. The Sun Ray architecture would be ideal in an environment where users needed to run both Unix and Windows based applications. It is also the only acceptable solution for high security networks processing classified data. Neither of these two conditions was required for the GSBPP and consequently the Sun solution was rejected to avoid the additional costs and dual server administration burden.

PC Expansion from nComputing

At the opposite end of the thin-client spectrum from the elaborate Sun Ray system described above is the PC Expansion model L100 from nComputing. This very simple light weight terminal does not even require a true network server but rather has the ability to add up to 10 users to a standard desktop computer. The shared desktop system can be running any of the following operating systems: Windows 2000 Professional, Windows XP Home, Windows XP Professional, Windows XP Media Center, Windows 2000 Server, Windows Server 2003, or Linux. With a street price of approximately \$190 it was by far the least expensive terminal we evaluated. The system comes with software to be loaded on the shared computer that provides the same functional capability as Microsoft Windows Terminal Server. Figure 3 below shows the ports available on the back of the unit. There are no other ports available and most notably missing are standard USB ports.

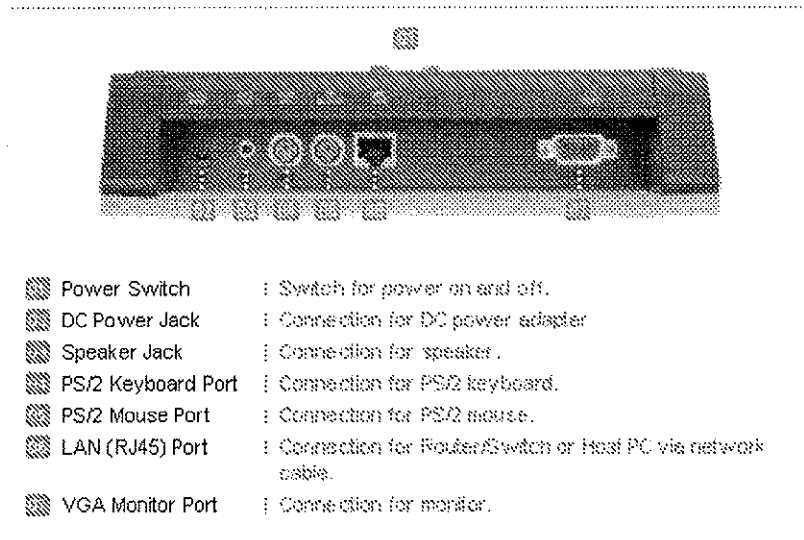


Figure 3: PC Expansion from nComputing

The PC Expansion terminals were easy to setup and performed as well as the other thin-client devices that cost several times as much. Unfortunately the systems had three disadvantages that eliminated them from being considered as a viable option. First was the lack of standard USB ports. GSBPP students require the use of thumb drives for data portability. Second was the limited scalability. Even with a Windows Server in the network the maximum number of users is thirty. The third problem encountered was a lack of compatibility between the nComputing supplied multi-user software and Microsoft security patches. On several occasions an automatic security update from Microsoft for the shared computer's operating system disabled the PC Expansion network. The network was inoperable until nComputing posted an associated patch for their software on their web site.

Wyse Technology Model S10

Wyse Technology is the market leader for thin-client computing devices. The Model S10 is their entry level device which is very compact, lightweight and solid-state (no moving parts such as disks or fans). The small size of the unit makes it especially convenient to mount onto the back of a standard LCD monitor (Fig. 4). The system includes a good number of ports including 4 USB ports, audio in and out, 9 pin serial, 10/100Base-T Fast Ethernet, and a DB-15 VGA port.

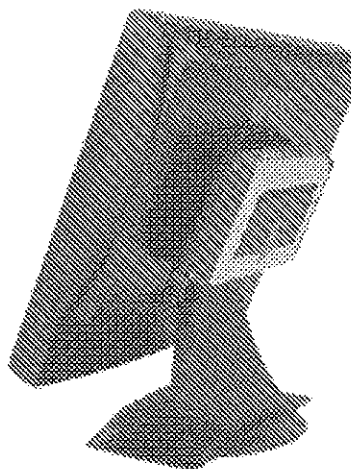


Figure 4: Wyse S10 thin-client mounted on the back of a LCD monitor

Street prices for the S10 averaged an affordable \$300 at the time of the study. The S10 uses a proprietary operating system called Wyse Thin OS. The system performed very well working with our Windows application server. The only disadvantage noted during testing was the limited compatibility of the built-in USB ports. The S10 operating system restricts the use of the USB ports to printing devices. The ports do not support external storage devices such as thumb drives. Unfortunately this was a key requirement for the GSBPP implementation and thus eliminated the S10 from further consideration.

Wyse Technology Winterm V90

Near the top of the Wyse Technology thin-client line is the Winterm V90. This was the system deemed most appropriate for the GSBPP environment. The terminal is quite a bit larger than the S10 making it impractical to mount on most LCD monitors. However, there are both vertical and horizontal mounting options which require a minimum amount of desktop space (figure 5).

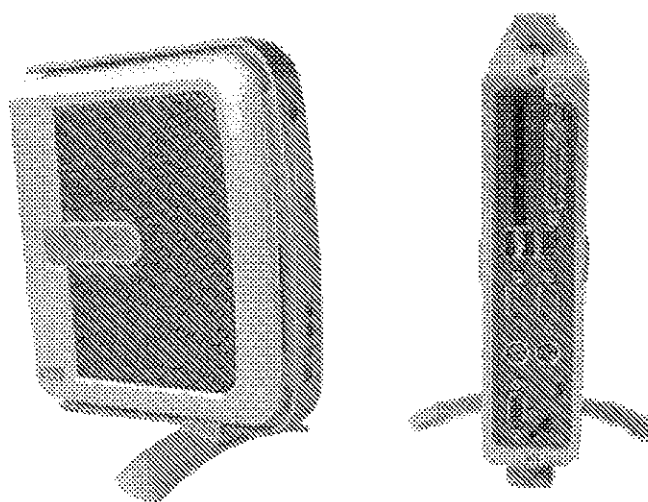


Figure 5: Wyse Technology Winterm V90

The Winterm V90 offers a wide range of external ports and uses a much more sophisticated internal operating system; Microsoft Windows XP Embedded (XPe). The full featured operating system enables the V90 to achieve a much higher level of plug and play compatibility with external devices. Several different thumb drives were tested with the system and each was recognized immediately and made usable by automatically being assigned an additional drive letter. Of all the terminals tested, the V90 provided the greatest functionality compared to a regular desktop PC while maintaining the advantages of a solid-state, maintenance free, low power thin-client. Table 3 lists the specifications for the system.

Processor	1GHz x86 CPU with high resolution 24-bit video controller
Memory	512MB flash/256MB DDR RAM
Input/Output/Peripheral Support	Two serial and one parallel port Three USB 2.0 ports CardBus/PCMCIA card slot PS/2 mouse and keyboard port Parallel printer port Internal smart card reader (Option)
Video	VGA output (DB-15)
Ethernet	10/100 Fast Ethernet

Power	~100 - 240 VAC, 47 - 63 Hz, Average Power Usage: 17.2 Watts
Cost (Approximate)	\$600

Table 3: Wyse Winterm V90 Specifications

Conclusions

Thin-clients have several advantages over traditional networked PCs in an academic classroom environment. The most significant of these are lower cost, ease of maintenance and administration, lower power requirements and increased reliability. This study found that, with just a few exceptions, the large majority of existing Windows applications being used in higher education are compatible with the thin-client architecture. The study also found there are a wide variety of thin client devices on the market and it is important to test prospective devices to determine whether they satisfy all of the user's functional requirements. The second phase of this research project will examine the issues involved with building a thin-client network as well as its on-going support and maintenance.

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INTRODUCTION

In the last 75 years, more than 60 published studies have examined the impact of K-12 school libraries (now known as library media centers) on student achievement (Laitsch, 2003). In the last decade a growing body of research including 16 state-wide studies has contributed mounting evidence of a positive correlation between U.S. school library media centers and student achievement whether achievement is measured generally in terms of learning, or more specifically in terms of reading scores or literacy (Scholastic, 2006). In particular, the presence and active participation of a qualified library media specialist in curriculum development, student instruction and teacher education have been shown to be a critical factor in attaining a positive impact on student achievement (Starr, 2000; NCLIS, 2005).

On January 08, 2002, President George W. Bush passed into law the bipartisan education reform effort labeled "The No Child Left Behind Act of 2001" which has become known by its acronym "NCLB" (NCLB, 2002). The NCLB was built on four principles: accountability for results, more choices for parents, greater local control and flexibility, and a greater emphasis on using scientifically-based research. Under the NCLB, by the academic year 2013-2014 all students including students with limited English proficiency are required to meet each U.S. state's proficiency level of academic achievement. In a direct response to the expectations of this Act, the American Library Association launched a campaign in November of 2005 mailing more than 78,000 brochures to administrators of private and public elementary, middle school and high schools in the United States to raise awareness of the significant role of the library media specialist in the context of the NCLB (ALA, 2005). The six page brochure offered research and support resources emphasizing the necessity of the centers and library media specialists in helping meet the requirements of NCLB.

This heightened awareness and resulting renewed interest in the importance of library media specialists in the wake of the NCLB's ambitious goals along with other contributing factors has prompted a number of states to pass legislation mandating state-certified library media specialists in their K-12 school library media centers. In most states, the library media specialists are considered teacher-librarians. That is, individuals first need to have a teaching certificate, and then only through successful completion of a recognized state library media endorsement program can they become state-certified library media specialists.

Consequently, this growing demand in many states combined with a wave of retirements, the movement of librarians into lucrative business opportunities (Donovan, 2002), and increased funding for public school libraries have led to a massive job surplus for library media specialists in the United States. In 2002, it was projected that by 2005 there would be more than 25,000 vacant library media specialist positions across the United States (Donovan), and a quick look at K-12 job ads in any state confirms this demand. This trend is expected to continue; by 2010, more than 83,000 librarians in the U.S. are expected to have reached the age of 65 (Matarazzo, 2000).

In the state of Washington, K-12 schools are not required (yet) to have state-certified library media specialists. However, strong wording in a March 28, 2005 revision to the Washington Administrative Code legislation governing Washington State library media centers and library media specialists highly recommended a greater emphasis and focus on these centers and library media specialists to promote student achievement (Washington et al., 2005). Some believe this action was a precursor to future legislation mandating library media specialists in all Washington K-12 school districts and schools. Regardless of the reasons, increasing numbers of K-12 school districts are moving to hire state-certified library media specialists and/or send their

current librarians for training to become certified. Consequently, some of the six institutions offering library media programs are experiencing record enrollments.

Library Media Endorsement Programs in Washington State

As of April 01, 2006, there were 22 (Washington) State Board approved education preparation programs at universities and colleges in Washington State. Of these 22 programs, six universities in four different cities (circled in red in Figure 1) offer a library media endorsement program for certified teachers. Two of these six universities offer programs which can be completed at a distance. In both these cases, program courses are provided entirely through online/web-based technologies and do not include any synchronous components. There is evidence to suggest that an online-only library media program (with little or no synchronous communication and interaction) may be an inadequate approach to developing the unique blend of competencies and skills needed for teachers being prepared for roles as future library media specialists (Shannon, 2002).

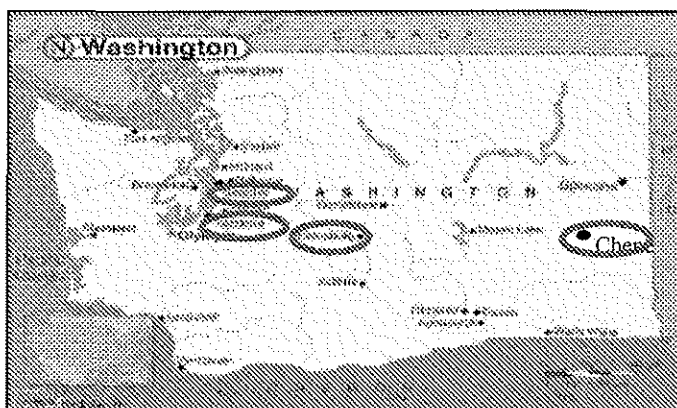


Figure 1. Locations of State Approved Library Media Endorsement Programs (OSPI, n.d.).

Table 1 below lists the six universities and their respective locations in Washington which offer State Board approved library media endorsement programs.

Table 1.

City Location and Names of the Six WA Universities Offering Library Media Programs

Name of Institution	City Location
Antioch University	Seattle, WA
Central Washington University	Ellensburg, WA
Eastern Washington University	Cheney, WA
Pacific Lutheran University	Tacoma, WA
Seattle Pacific University	Seattle, WA
University of Washington Seattle	Seattle, WA

The Library Media Endorsement Program at Central Washington University

Central Washington University (CWU) has been offering the library media program as an endorsement for certified teachers since the early 1990s. The program is housed in the Department of Education at CWU, and as such is administrated and taught by faculty in the department. Our 27 credit course program is unique in that the entire program can be completed

over two summers and one academic year. Teachers take eight of their nine 3 credit courses on campus at CWU during one month each summer over two consecutive summers. Their ninth course, their practicum course, is completed during the academic year between the two summers at a K-12 library media center of their choosing anywhere in the state. The convenience of the summer-only program is attractive to many K-12 teachers, but there is still a significant number of teachers who would prefer to take courses over the academic year instead without having to give up their summers for coursework. Unfortunately, due to population and geographical factors, we are unable to successfully attract certain K-12 teachers on-campus during the academic year. As a result, we are now considering the possibility of a DE library media program offered during the academic year to target this growing market segment. This paper takes a first look at the feasibility of developing a Distance Education (DE) library media endorsement program at CWU.

Consideration of Washington State Population Distribution and Geographical Factors

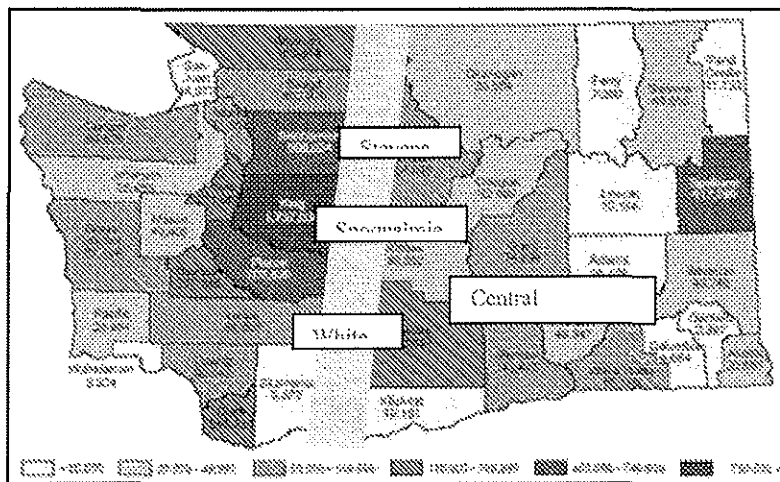


Figure 2. Population Distribution in 2000 in Washington State (WSDOT, 2003).

Figure 2 presents the population distribution in the year 2000 in the state of Washington organized by counties. The yellow band superimposed on the map represents the approximate location of the Cascade mountain range. As figure 2 displays, as much as 75% of the state's population is located west of the Cascades. The three largest counties in the state, Snohomish, Pierce and King, are home to more than 50% of the state's population. Certified K-12 teachers planning to add a library media endorsement to their teaching certificate and electing to attend CWU would have a minimum of a 90 minute drive one way. This in itself is a deterrent for many potential program students since these individuals are typically K-12 teachers with only evenings and weekends available for coursework.

Furthermore, the Cascades Mountains positioned between the densely populated counties on the west side and the city of Ellensburg (the location of CWU) poses a huge obstacle and travel risk during the fall, winter and spring months. The three Mountain Passes providing interstate access to CWU include Snoqualmie Pass, Stevens Pass and White Pass which range in elevation from 3022 feet (Snoqualmie Pass) to 4500 feet (White Pass) (DOT, 2006). Figure 3 identifies the general location of these three Passes. This past winter 2005-2006 saw a record snowfall in the Cascade Mountains with avalanches and rock slides causing delays and shutting

down several of the Passes for hours, days and in some cases, even weeks. Consequently, due to these geographic and inclement weather challenges which can be present for as many as seven months of the year, offering traditional library media courses (e.g. in a face-to-face mode) during the academic year is a losing proposition. As a result, a distance education (DE) option could be a viable alternative for CWU to gain a portion of the growing numbers of teachers requesting library media endorsements who may be located anywhere in the state. A DE approach to address physical distance and in particular when students are unable to attend a campus and are working adults with family responsibilities, and to deal with issues of low and/or dispersed enrolments is considered an effective strategy to overcome these barriers (Crawford & Crawford, 2005; Roberts & Keough, 1995).

Washington State's K-20 Network

In 1996, the Washington Governor and the Washington Legislature enacted legislation and released funding to develop a high-speed, high-capacity telecommunications network to connect all of Washington's public colleges, universities and K-12 school districts with a major goal of eliminating the traditional constraints associated with distance and cost (DIS, 2006). The network was to include state-wide access points to the Internet, videoconferencing, and satellite-delivered-video services. With appropriated funding totaling \$61.4 million, by 1999 the K-20 Network was implemented and fully operational linking 400+ public education sites across the state. Figure 3 represents the pervasiveness of the Network in every "corner" of the state. The success of this program has led to the funding of an additional 66 public library and 15 private baccalaureate sites which are now close to completion. The nine K-12 Educational Service Districts (ESD) each provides a number of access points allowing K-12 teachers from anywhere in the state to access the Network either at their school or within a short distance of their school.

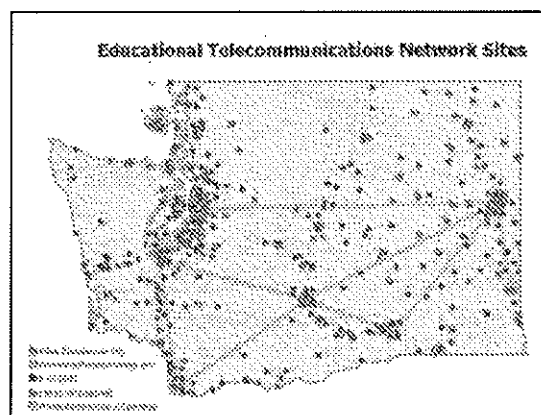


Figure 3. Washington State Population Distribution in 2000 (DIS, 2006).

The administration, support and technical operations of the K-20 Network are provided by the State Department called the Office of the Superintendent of Public Instruction along with partnerships with regional and school level institutional technical units. Any K-12 teacher using the K-20 network receives free training and support. In addition, all K-20 sessions requiring a Distance Education operator is facilitated at no additional cost to the teacher, school or district.

A Framework to Examine the Feasibility of Distance Education Library Media Program

In determining the feasibility of a DE library media program, it's useful to examine this program within the context of the 10 key functions of a distance education institution or agency (Crawford & Crawford, 2005). These functions include:

1. Recruiting and Marketing;
2. Enrolling and Registering;
3. Examining, Crediting and issuing Credentials;
4. Obtaining and Managing Money and other Resources;
5. Acquiring or Developing Courses and Programs;
6. Producing, Reproducing, Storing and disseminating Materials;
7. Delivering Courses and Programs;
8. Teaching Students;
9. Supporting Students; and
10. Evaluating and Revising Courses, Programs, Processes and Procedures.

Following initial acceptance and approval of this preliminary proposal, the subsequent proposal will involve a deeper analysis of the feasibility of this program in a DE format. The framework suggested above will be most useful in this regard.

Conclusion

This preliminary and incomplete proposal has taken a cursory look at the possibility of implementing a DE route for the library media endorsement program at CWU. At this stage, the findings of this brief proposal appear promising warranting collection of further data and a more thorough examination and deeper analysis of these data. In addition, the next steps will necessitate the involvement of DE individuals, library media instructors, and program administrators to actively participate in the decision-making process of determining the real feasibility of success of developing and subsequently implementing a DE program. Because much of the technical and support infrastructure is already in place and integrated in sunk costs, and since many of the existing processes such as registration, enrolment and assessment could be adopted for the DE model with little or no changes, the initial outlay of funds appear to be minimal. Of course, a more extensive investigation into the feasibility of a DE program and a thorough cost/benefits analysis may prove otherwise.

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Selection and Implementation of E-Portfolio Systems: Lessons Learned

Introduction

Our Teacher Education Program, one of the oldest and largest in the State, is currently preparing for our upcoming NCATE and State accreditation visitation in the spring of 2007. This visitation is unique in that it is the first for which we are using an electronic data system, following NCATE's move toward a data-driven model of unit and program evaluation. Having had no program-wide portfolio system previously in place, the transition toward an electronic system was particularly difficult, introducing technical, logistical, and pedagogical challenges.

Over the last three years, we have learned many important lessons concerning the effective selection and implementation of such a system. These lessons fall into two major categories: Selection of an Appropriate System and Implementation Issues.

Selection of the Appropriate System

When selecting an e-portfolio system, there are a number of critical areas to review including e-portfolios versus assessment systems, the cost structure, technology considerations, and faculty buy-in.

E-portfolio vs. Assessment System: Your first consideration is the type of system you require. An e-portfolio system lends itself to a student-driven collection of artifacts, revisions, and reflections. In contrast, an assessment system is more program-wide in nature and affords the easy collection and analysis of data. There are also integrated systems incorporating elements of both e-portfolio and assessment systems.

Cost structure: Costs are associated with either system but the cost structure varies and is contingent on a number of factors. For example, the system costs may be absorbed by the institution or the student or a combination of the two. In addition to purchasing costs, other costs include annual maintenance and upgrades, user support, licensing fees, facilities including equipment, and switching costs. System options include open-source, off-the-shelf and proprietary with each having benefits and challenges depending on the institutional context, needs and resources.

Technology Considerations: Selection of a system requires institutional IT support. Additionally, compatibility with existing institutional IT systems and policies including course management systems, platforms, student information systems, existing assessment systems, is critical. Customizability and flexibility of the system to incorporate specific institutional needs regarding reports, data entry, format and other relevant factors such as alignment to national/state/local standards is equally important.

Faculty Buy-In: The last area, and arguably the most critical, is faculty buy-in. Involving faculty in the selection of the system will pay dividends throughout the implementation process. The faculty selection process should consist of a comprehensive needs assessment considering: needed features, ease-of-use, adequate end-user documentation,

value, and compatibility with existing practices and policies. With faculty ownership of this process, faculty will be more committed and supportive of a faculty-friendly product which they consider valuable and instrumental to the success of the ir teacher preparation program and in turn, supports the efforts of the accreditation process.

Once the appropriate system has been selected, implementation issues must be addressed.

Implementation Issues

Implementation Plan: The most critical piece of implementation rests in the development of a well designed implementation plan. Although an implementation plan can incorporate many components, the most pertinent are building a strong implementation team and establishing a working timeline.

Implementation Team and Roles: The implementation team is typically comprised of personnel at your institution who have tacit knowledge and/or motivation to learn the necessary skills and knowledge in the roles listed below. Your team may include outside expertise such as data specialists, change agents and accreditation experts. Implementation teams vary in number, and according to several commercial e-portfolio systems, should encompass the following roles:

- E-Portfolio/E-Assessment System Coordinator
- Accreditation Coordinator
- Assessment Manager
- Faculty Coordinator
- Student Coordinator
- IT Personnel
- Program Directors
- Teacher Preparation Program Administrators
- Training Facilitators

Working Timeline: One of the first tasks of the implementation team is to develop a working timeline. This timeline coordinates, informs and guides the entire implementation process. A timeline should work backwards. By this, we mean you must first begin by identifying your final goals and products within a “roadmap” that clearly presents an overview of the entire process. Next, break these goals into manageable tasks, events and assign deadlines. Finally, assign implementation team members to be responsible for oversight of these tasks.

By clarifying and articulating the “big picture” in a concise document, faculty, students and administrators have a consistent reference and a shared vision of the process, expectations, tasks, responsibilities and deliverables. Deliverables may include: course syllabi; program information; student evaluations; meeting minutes; admission requirements; standardized test scores; faculty evaluations; faculty vita; faculty and student demographics; program assessments; student artifacts; revisions and reflections; and other relevant documentation. Benchmarks offer predetermined checkpoints for

formative evaluation, and based on evaluation results, a modification of the timeline and implementation plan may be necessary. An added value of this “big picture” is to quickly and effectively induct and orient new faculty and administrators to this important endeavor.

Contingency Plan: As with any endeavor involving technology, it’s critical to have a contingency plan in place. This would address alternative methods and processes for collecting, analyzing and reporting data in the event the system is no longer available due to malfunctions, inaccessibility, or other unforeseen circumstances.

Support Structure: Once an implementation team has been assembled, a timeline established and a contingency plan developed, the next step is to create a support structure. This should consist of: customized training documentation to reflect the institutional needs; scheduled class training for faculty, staff and students with opportunities for 1 on 1 support; a website presence to communicate and disseminate training materials, support information, and other pertinent information; and establishment of a Helpdesk office to provide phone, e-mail and in-person support. Ideally, all training should necessarily integrate both the technical-know-how as well as the pedagogical implications of using the system.

Administration: Administration encompasses the areas of accountability, communication and coordination, and routine maintenance. Accountability should include incentives to motivate faculty and students, to ensure timelines are adhered to, and sufficient and ongoing progress is being made. Communication and coordination involves regular contact with all levels of participants such as faculty, program directors/administrators, assessment officers, vendors, IT and support staff, and accreditation agencies. Coordination efforts consist of providing opportunities for feedback, establishing contact points for various tasks and events, and collectively trouble-shooting problems. While the communication and coordination of participants is critical, so is the coordination and management of the various activities and documents in the system. This task can be overwhelming if not organized and planned well.