The Effective Use of Technology in Correctional Education

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From June Cleaver's new toaster oven to today's smart architectural surfaces, technology has promised ease, speed, and efficiency for decades. Indisputably, technology has improved our tasks and communication. Few would argue, however, the accompanying irritations and limitations exact a price. Technology is both the blessing and the blight of our daily lives.

The breadth and scale of technology in correctional education could consume an entire round table in itself. This paper supposes a framework designed to create a stage for discussion: a brief review of the historical expectations for technology in correctional education, a current portrait, and a focus on future directions.

Historical Expectations

The introduction of both the mainframe and minicomputer and the teacher shortages of the 60's and 70's paved the way for technology's arrival into the public school classroom. A promise of instructional assistance and record-keeping systems that would make educators more efficient grew to include enthusiastic acceptance of technology as the answer to inadequate resources.

The historical expectations for technology in correctional education mirrored that of public schools, albeit often lagging years behind public schools. The first uses of technology in prisons were usually in schools and treatment services – maintaining databases on offenders, rather than instructional or resource supplements – and in law libraries, providing electronic resources. As prison populations exploded over the last two to three decades, correctional systems turned more frequently to technology as a way to track and store offender information. Significant and legitimate fears prevented initial use of technology for instructional purposes. However, correctional educators came to recognize that technology might provide partial resolution to two pressing issues: underserved populations and understaffed schools. Computer-aided instruction, audio/visual aids, and pre-packaged programming satisfied a variety of needs ranging from stand-alone instructional surrogate to direct instructional complement. As computers, record-keeping systems, and instructional software became more commonplace, harnessing technology to enhance the toolboxes of educators and to serve the needs of individual offender students absorbed more budget and space, in hopes of rounding out inadequate resources.

Vendors quickly discovered a lucrative market and heavily invested in correctional education technology development and sales, an increasingly frequent presence at correctional conferences. Corrections-specific technologies from vocational tools to satellite instruction flooded prison education and promised the answer to:

- reaching isolated or geographically remote populations
- addressing a broad range of learning styles and academic readiness
- providing corrections-specific content with security-conscious protocols
- serving segregated criminal sub-groups

Those with the most wide-spread marketing strategies gained the lion's share. Schools with federal dollars to spend or under political pressure to expand technology training for both staff and offenders invested in these tools and services. Some turned out to be appropriate and successful strategies. Others faded in the light of practical security concerns, budget challenges, or implementation barriers.

Until very recently, no corrections-specific higher education training or certification existed for educators. Therefore, those who found their way to correctional education often did so following careers in public education, bringing with them philosophies and practices concerning technologies used in public schools. In some instances, this included licensure requirements demonstrating technological competence. Adapting these policies and practices to the unique environments of prisons ranged from outright rejection to enthusiastic acceptance of all potential technologies. Still today, this evolution swings back and forth with changes in leadership, policy, politics, and front-line personnel. Experienced correctional educators often encounter the *what-goes-around-comes-around* cyclical nature of education technology. Flexibility and open-mindedness create schools where technology can find a balance between blessing and blight.

Technology was initially introduced through, and continues to be strongly linked to, vocational education. What was called Industrial Arts decades ago pioneered hands-on technological solutions to training and career preparation for offenders. However, research continues to demonstrate that academic opportunities for offenders, including technology, must keep pace with vocational options. For instance, Work Keys assessments common in Workforce Investment Act programs include both academic- and skill-based appraisals. The migration of technology from vocational training to academic preparation has contributed to the debate about academic versus vocational programming for prisoners.

Intuitively, vocational courses hold some appeal; they often take less time to complete than academic courses of study, and they offer work-related skills that prisoners may use immediately upon release. These qualities make vocational courses more palatable to legislators who must justify offering higher education to prisoners (Erisman & Contardo, 2005). The question that remains, however, is whether vocational education offers the same benefits as more traditional academic work. Batiuk et al suggest that, while vocational training programs such as apprenticeships reduce recidivism, they do so less effectively than traditional post secondary education programs (Erisman & Contardo, 2005).

Technology should contribute to this balance of opportunities by expanding access, improving persistence, enhancing quality, and increasing completions in both vocational *and* academic pursuits.

The key to learning from an examination of historical expectations of correctional education technology lies in seeking balance: balance among tools, training, and time. Technology should serve us, not the other way around. A frequent and common complaint among correctional educators is the sudden bombardment of the latest technological solution without being given adequate training in its use or sufficient time to discover how to best integrate it. This dilemma exists in all applications of technology from instructional aids and record-keeping to reentry communication systems. Throwing technology at educators and offenders alike and expecting immediate acceptance or results is not an end in itself. Technology must be deliberately identified and purposefully integrated.

Current Portrait

The use of technology has begun to swing away from the ultimate answer to a more practical enhancement of educational goals and practices. As technology became more integrated in the classroom, educational governing and administrative oversight bureaus began to develop technology standards for educators. Today most states require educators to provide some verification of technological competence. This widespread acceptance of technology's stamina is encouraging. From retro-fitting older prisons to planning new construction, technological foundations must be considered. The omnipresent nature of technology in free society compels us to equip offenders for its application prior to their release.

Common platforms available in correctional schools include:

- CD's / DVD's
- Closed circuit
- Intranet
- File servers
- Computers, stand-alone or networked
- Local Area Networks
- Wide Area Networks
- Two-way audio/video conferencing
- Internet Protocol TV
- Satellite
- Instructional TV Fixed Service (microwave)
- Learning content systems such as NovaNet, WebCT, or Blackboard

Today even the most remote and barren prison schools have some combination of these platforms. Each of these requires budgets, methodologies, infrastructures, and security approval. An exhaustive list for each is prohibitive in this venue; however, specific requirements for emergent platforms are addressed later in this paper as they relate to feasibility studies and defining the vision for correctional education technology.

Exemplary employment of education technology can be found in multiple states throughout the nation. No accounting can hope to capture them all; however, the authors have particular knowledge of these commendable and potentially replicable strategies or pilots:

- Ohio's *Transitional Education Program* utilizing distance learning videoconferencing technology to link offenders to communities (Mark.Roberts@odrc.state.oh.us)

- Wisconsin's College of the Air academic programming broadcast via the Transforming Lives Network satellite (www.tln.ceanational.org)

- Oklahoma's synchronous instruction statewide

- Eastern New Mexico University's Internet Protocol-based post secondary offerings via Web CT, secured through the New Mexico Corrections Department of Education Server (Jeff.Wilson@state.nm.us) or (Lorenzo.Ruiz@correctionscorp.com)

- Federal Bureau of Prisons closed system with a time delay allowing offenders e-mail experiences and electronic law library access

- Iowa's use of an internal networked system allowing access to offender handbooks, canteen orders, downloaded newspapers, dietary menus, offender FAQ's, schedules and other paper- and staff-saving tasks

- An Interactive Graphic Media & Web Design program located at Ohio's London Correctional Facility which designed the new TLN website (Steven.Galloway@odrc.state.oh.us)

- Alaska Hiland Mountain Correctional Center's Microsoft® Office Specialist (MOS) and IC3® Certification programs

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Consigning education technology only to supplements for teachers or instruction for offenders, however, would not present a complete picture. Discussion about the current and future use of technology must include the following broad applications:

- institutional communication systems linking offenders to services and information
- capturing, maintaining, and retrieving accurate educational data
- training in technological fields
- connecting offenders to their families and communities prior to release
- exploration of secure Internet access
- post-release technology relevance

Daine Ravitch (2003) of New York University states:

> If we learn from history, we will recognize that education cannot become a respected and durable profession until it establishes its practices on a solid foundation of valid research. We must insist on better evidence, more randomized trials, and replicable studies. Education will not achieve the status that it deserves until there is carefully constructed,

> validated knowledge about how to improve student learning, as well as how to measure student learning.

The same rings true for education technology. Research validating the effective uses of technology is critical to bringing credibility to its use in the field. In fact, this is happening. The Correctional Education Association is currently involved in two projects providing this necessary research. The first is an Institute of Education Sciences (IES) scientific research grant and the second is a feasibility study of all potential technology platforms.

IES Project: *Developing a Program of Postsecondary Academic Instruction Over the Transforming Lives Network*

The *College of the Air* curricula delivered via the Transforming Lives Network (COA/TLN) has great potential to increase access, persistence, and completion of courses by incarcerated youth leading to postsecondary degrees. This study seeks to obtain impact data to determine the efficacy of this approach.

Forty-four prisons with a high concentration of youth offenders (aged 18-25) in Arizona, Colorado, Iowa, Minnesota, Oklahoma, and Wisconsin comprise the sample for the study. These prisons represent a combination of custodies; reflect the racial/ethnic diversity of their state inmate populations; and consist of male and female inmates, with a disproportionate representation of incarcerated males, reflecting the more general characteristics of U.S. prisons. The population from which study participants will be sampled includes inmates: (1) between the ages of 18 and 25; (2) with a release date between 1 and 5 years; (3) in possession of a high school diploma or equivalent; and (4) whose tuition costs are paid through external grant funding.

RMC Research of Denver has designed the research methodology. A cluster randomized trial design is being used in which prisons are randomly assigned to receive COA/TLN programming or other programming that would normally be offered. Outcomes for participants in COA/TLN and control sites will be compared. Participant outcomes to be examined include academic achievement, achievement motivation, educational aspirations, progress toward completing a postsecondary degree, and improved employability. Outcomes for institutions include participation in postsecondary and other academic programming, institutional climate, and rates of recidivism.

Qualitative data collection will include observations and interviews with participants and administrators in a representative sample of sites. These data will be used to closely examine implementation components, to triangulate data collected using other methods, and to inform design and refinement of COA/TLN content and delivery.

Data analyses will examine: (1) the nature and extent of COA/TLN instructional delivery and associated institutional support; (2) the nature and extent of inmate participation in COA/TLN and other types of postsecondary academic instruction; and (3) the effect of COA/TLN on participant outcome measures.

Hierarchical linear regression models (HLM) and repeated measures analysis of covariance (ANCOVA) will be used to examine participant and institutional outcomes, respectively. Measures of participant exposure to different aspects of course content and delivery, participant and institutional characteristics, and other factors will be examined to provide information about the extent to which these factors mediate the impact of participation in COA/TLN.

Supplied with such impact data on access, persistence, and completion, CEA hopes to raise the level of awareness of technology's relevance and increase technology's use in correctional education nationwide.

Feasibility Study

CEA applied for and received a US Department of Commerce planning grant supplying the necessary funds to meet the following objectives:

- conduct a feasibility study and needs assessment of all potential technologies for delivering distance learning educational programming to offenders
- conduct a location feasibility study to identify an appropriate and cost effective location to place distance learning technology
- prepare a technology equipment inventory and installation plan for an independent facility

CEA is working to increase staff and offender access to corrections-specific programming in our nation's jails and prisons through the Transforming Lives Network. The goal is to move toward independently owned and operated distance learning technology, freeing CEA to make the kinds of delivery, content, and production decisions necessary to keep TLN essential and attractive to the correctional education field. An operational plan for the future of TLN is being created. What follows is a distillation of several technology platforms being explored by CEA for nationwide delivery:

Platform: Synchronous instruction - Point to multipoint			
Instruction from a single point over a two-way audio/video camera to several receive sites			
Required Infrastructure	**Anticipated Cost**	**Advantages**	**Limitations**
Dedicated T-1 line Polycom-like unit Push-to-talk mics Bridge (if exceed 4 sites) I.T. support Telephone hybrid operator available at each site for call-in questions	Installation of T-1 lines to institutions dedicated to education need ~$250-$300 one time cost ~$900 per month each site for dedicated T-1 Polycom-like unit $2500–6,000 Bridge Service (bringing several sites into one feed). Pay per line per usage. The cost usually runs 5¢ per minute per line ($3 per hour per line) up to a certain number of lines. Above that number there would be a setup charge to add additional lines. Specifying the number of lines needed each time is necessary. Services charge $10 per line for each line not used. So if 10 people are going to dial in, but at the time of the conference only 8 people actually make it, then must pay $20 on top of the usage charges incurred by the other 8 lines.	Brings students together virtually for study and discussion In post secondary courses, provides critical social interaction with on-campus classrooms (virtually) Immediate student assistance from call-in to instructor Immediate instructor feedback Push-to-talk mics reduce ambient noise	Majority of prison sites have limited or no access to T-1 lines in school buildings; if there, not dedicated to education (rather shared with department network) Without dedicated T-1 to education, buffering, freeze-frame, and other quality issues arise frequently as network line fills up Remote sites have no T-1 access Limited I.T. support Expense of T-1 lines Does not accommodate full motion video quality Addressing 6 time zones simultaneously Guided discussions on live broadcast work best for live replay; taping and replaying creates lack of immediate accountability, students make fun of those who answer on taped show whereas live broadcasts generate responsibility Production reflects a tendency toward *talking head* over full motion video

Platform: IPTV instruction - Point to multipoint			
Instructional video one-way over Internet to sites with Internet access at sites and/or in classrooms			
Required Infrastructure	**Anticipated Cost**	**Advantages**	**Limitations**
Minimum DS3 line to send out instructional broadcasts Business class DSL or greater at each prison site to receive (minimum 1.5 - 2.0 Mb/s line into each prison … or recommend a preferred ISP to deliver the service to subscribers) Instructor access to Internet Security: making Internet one-way, accepting incoming streams only	$5000 to get **to** cloud (for ease of conversation for the non-technical, the Internet's infrastructure is referred to as a "cloud.") To get **into** cloud requires a burstable 20 MB service (up to 20 MB use) ~ $1,800 per month – potentially a sliding scale based on average use. $1,800 represents ~10MB per month use. ~$50 per month to transmit **from** cloud (local Internet Service Provider) Micro router (firewall device to ensure Internet can only accept incoming streams). $275-$300 one time cost. Requires significant I.T. expertise to set up and maintain (additional expense at each site/department).	Immediate and unlimited access to countless high-quality curricular video materials On-demand training and curriculum Content distribution easily managed to TVs and computer desktops Full motion video available even on larger screens Elimination of recording every program Uses Internet for distribution; however, requires decoder with unique IP address and Smart Card with encryption authorization key to receive signal. No direct access to Internet or World Wide Web.	Selling anything "Internet"-based to prison security and administrators Providing ample I.T. staff dedicated to educational needs to monitor security of Internet; building and maintaining Internet security with stops at each potential branch often very complex and labor intensive at each site. A secure "closet" would be necessary at each site so that it could not be tampered with by local personnel. The firewall can then be remotely administered by an I.T. person off site once it was initially set up. IPTV can sustain 24/7 programming, however it has service issues. The buffer requirements for Internet video transmission are large, resulting in unacceptable delay. Even with these large buffers, disturbances still occur. The Internet by itself would be a challenging transmission medium for professional video-over-IP applications, but in many cases, the Internet does allow for the transport of video over IP using virtual LAN (VLAN) technology. Scheduled availability – can be dispensed to the viewer on a schedule, however that would require some schedule management software; questionable if something like that is available off the shelf. Sites bear bulk of costs, discouraging participation Retro-fitting older prisons to T-1 lines or dedicated education Internet connections is cost prohibitive Access to Internet Service Providers is limited or non-existent in remote geographic areas

Platform: TLN Satellite - Point to multipoint			
Instruction beamed from satellite to dish mounted on site roof; received through decoder and TV monitor at each site in real time			
Required Infrastructure	**Anticipated Cost**	**Advantages**	**Limitations**
Two vertical racks of equipment (Nexus Video Server, High Power Amplifiers, two MPEG-4 Encoders, Multiplexer, Conditional Access Scrambler, Subscriber Management System, Conditional Access Server, Upconverter, DVB-S2 Modulator) 4.5 meter or greater uplink antenna 4.5 meter or greater downlink antenna Leased satellite space segment Telephone hybrid operator available at each site for call-in questions Encryption equipment Backup system	$140,000 encryption equipment $160 decoders per site $11,000 per month transponder fees ~$7500-9000 per month for teleport labor Two vertical racks of equipment for complete uplink system and ad-hoc downlink system (with backup) ~$200,000, including 4.5 meter uplink antenna Backup encoders, multiplexer, and encryption ~$120,000	Satellite reaches everyone everywhere with simple dish and decoder, eliminating remote site access issues Live broadcast capability; live staff development available in training room with call-in phone Ideal for longer instructional segments Encryption allows more control over site participation vs. *in-the-clear* broadcast Accommodates full motion video quality and better resolution quality CEA bears bulk of cost, encouraging sites to participate Cost effective Leasing satellite segment space to private prisons for proprietary distribution is revenue-generating possibility Encrypting permits Forced Tuning, which allows broadcast of proprietary information simultaneously Upgrade current MPEG-2 decoders to MPEG-4 (allowing more information sent over less bandwidth)	Multi-media experiences offered by online courses and critical to the nature of offender learners is lacking in this delivery mode Guided discussions on live broadcast work best for live replay; taping and replaying creates lack of immediate accountability, students make fun of those who answer on taped show whereas live broadcasts generate responsibility Addressing 6 time zones simultaneously Upgrade to MPEG-4 requires nationwide upgrade of decoders Leasing satellite segment space to generate revenue may present need to censor or edit others' broadcasts; potentially prohibitive Data capacity limited to video only During local storms and equinox sun outages satellite can be interrupted causing pixilation and brief complete blackouts

Platform: ITFS (Microwave) - Point to point			
Instruction over video signal to line-of-site receiver			
Required Infrastructure	**Anticipated Cost**	**Advantages**	**Limitations**
Prohibitive for nationwide delivery; localized to line-of-site within 20-30 (maximum) miles of transmitter	~$6000 transmitter ~$2500 receiver $200-1000 short range; $2000-6000 long range	Secure operation at a lower power Both transmission and receive equipment affordable for local sites	Geographic barriers prohibit transmission Limited or no channels available in metropolitan areas where all available channels are in use

Platform: Browser-based asynchronous learning - Point to Point			
Instruction over dedicated private line using Internet technology without actual Internet connection			
Required Infrastructure	**Anticipated Cost**	**Advantages**	**Limitations**
Telephone line/T-1 line preferred Server to serve content individual computers Connection to local LAN (a networked lab)	Installation of T-1 lines to institutions dedicated to education need ~$250-$300 one time cost Local T-1 connections are ~$900/month Computer network costs Server $8000 each depending on bulk of content	Multi-media, high quality Internet-based instruction in a closed network Uses the Internet Protocol without actual connection to the Internet by traveling on the LAN Interactive instruction with a Internet-like experience for students Full motion video available even on larger screens (with possible end-user limitations) Asynchronous access; eliminates recording programming Automatic feedback on assessments Learning experience enriched with easy access to supplementary information	Selling anything “Internet”-based to prison security and administrators Each student needs access to a computer Sites bear bulk of costs, discouraging participation Retro-fitting older prisons to T-1 lines or dedicated education Internet connections is cost prohibitive

Of course no discussion of technology in prisons would be complete without considering Internet options. When Milwaukee Area Technical College was approached with the opportunity to provide post secondary academic courses to offenders over satellite, they were pleased to find a new use for their telecourses by broadcasting them via satellite. Colleges and universities nationwide are moving almost exclusively to Internet-based delivery of distance learning coursework; telecourses were waning in interest and application.

The Sloan Center at Franklin W. Olin College of Engineering and Babson College has released its fifth annual report on the state of online learning in the nation's colleges and universities (2007). According to this report, increasing student access is the leading reason why institutions offer online courses and programs. Supported by responses from more that 2,500 colleges and universities, the report states that almost 3.5 million students were taking at least one online course during the fall 2006 term, a nearly 10 percent increase over the previous year. Two-year associate's institutions have the highest growth rates and account for over one-half of all online enrollments for the last five years. Encouragingly, academic leaders do not believe that there is a lack of acceptance of online degrees by potential employers. According to the report, barriers to widespread adoption of online education include the need for more discipline on the part of online students and higher costs for development and delivery of online courses.

The advantages of Internet-based technology in free society *and* prison schools are numerous. Immediate and unlimited access to countless high-quality programming, training, and resources would significantly increase educational opportunities and staff development. Connecting pre-release offenders to their families and communities through e-mail and video streaming could increase the probability of successful reentry. Practical experience with the Internet prior to release better prepares offenders for the ubiquitous nature of this resource.

Obvious security concerns, however, breed caution in every discussion of Internet-based instruction within prison walls. As the feasibility study indicates above, security measures exist to prevent security breaches. However, two significant barriers stand in the way of such implementation: selling anything with the word *Internet* to correctional administration, and providing ample I.T. staff to monitor security stops at each potential branch. This is often very complex and labor intensive and required *at each site,* although control can be maintained remotely from a central headquarters location. Additionally, a secure "closet" would be necessary at each site so that it could not be tampered with by local personnel. Despite these barriers, access to the Internet is the current and future portrait of academic engagement. These barriers must be overcome to prove its viability, even if only in small pilot episodes.

Again, a solid foundation of both research and experimentation is necessary before Internet will be widely utilized in correctional education. We do believe it will happen. It is often a matter of departmental priorities and political climate and most certainly a state-by-state venture.

A further consideration in any discussions about Internet instruction involves consumer awareness. Judicious use of leisure time is often a

component in life skills instruction. Program plans for technology instruction may soon contain coaching in virtual worlds with regard to their limitations and risks. Creating Internet-like experiences for offenders has real and practical value and is unquestionably better than no exposure whatsoever. However, the current and rising national addiction to video gaming and simulated realities is of real concern for offenders who have historically displayed little self-discipline, poor time management, or fantasy thinking. It may be that the future charge of appropriate technological education includes instruction in the intelligent and balanced consumption of technology.

Cost Benefit

The most cost effective technologies tend to be those that: a) provide immediate assistance not available through other means and b) are available to both offenders and staff. For example, COA courses offered over TLN are the only sequential post secondary academic courses available to many correctional facilities and, therefore, save states dollars in both direct instruction tuition costs and long-term re-incarceration costs. All out-of-state tuition costs are waived. Other TLN programming such as GED preparation, literacy, and life skills may be more readily available through other means making such programming an incidental yet valuable supplement. The cost benefit of such a supplement is difficult to track; sites simply do not have the resources to track what they are *not* spending by being provided incidental services packaged with desired programming. No sites estimate the cost of resources or training they *might* be providing without TLN.

One critical benefit of any technological assistance that cannot be quantified into dollars is the corrections-specific nature of that technology. For instance, many vendors create or adapt their materials or services specifically with correctional environments in mind, thereby saving educators the time and expense needed to do so. The copper and fiber cabling program C-Tech is one such example, a pre-packaged, shadow-boarded, portable technology marketed with great success to prison schools.

Perceived value is a consolidated measure of the difference between the perceived benefits of technology and the cost of implementation. If the perceived benefits of a particular technology exceed the actual cost in potential student and staff development programming (or other applications) otherwise available, then sites are experiencing the *perceived value* of that technology. Perceptions are critically important for both consumers of technology and those who must sell its value to, say, administrators. What are the strategic objectives of the technological expansion? Is the attainment of the objectives probable with implementation? Or is the expansion simply a matter of convenience or budgetary restrictions? Perceptions may very well sway the response and eventual success or failure of implementation.

Applications

What are the lessons learned through this examination of educational technology? What are the non-negotiable components that must be incorporated

into future discussions and decisions regarding technology? If the principle *form follows function* is considered, a comprehensive needs assessment must first be conducted by each site before expanding technological platforms. What is the intended purpose of each platform? Are we purchasing things and services that are within our means and meet security requirements, rather than defining the intended outcomes and seeking deliberate technological assistance in the journey toward those outcomes?

This is nowhere more important than in student record-keeping. Accountability measures are no longer elective. Programs must prove their effectiveness through demonstrated advancement, completion, and a reduction in recidivism. Technology can assist us in this quest or it can become the albatross that prevents its achievement. In our work as correctional education consultants the data systems we observe that are creating labor redundancies are appalling. Educators are rarely consulted when new data systems come on board; yet capturing, maintaining, and retrieving reliable data with these systems is compulsory. Educators must continue to participate in the selection and formation of data systems so that educational programs can be reliably tracked, outcomes accurately measured, and results widely disseminated.

How should we define the *function* of technology in regards to instructional use or professional development so that we can determine its *form*? If technology is primarily supplemental are we retro-fitting it in stand-alone applications? Only through deliberate identification of its function in the classroom or the training room, planned implementation with time calculated for training and integration, and regular assessment of its ongoing effectiveness will technology serve us rather than the other way around.

Non-negotiable components of technology's inclusion provide broad application to other confined or remote populations. By ascribing to the following practices technology may achieve universal appeal and relevant purpose:

- calculated and deliberate selection, expansion, and integration of technology
- continued migration of technology from vocational to academic pursuits
- balanced employment of tools, time, and training
- methodical and vigorous research of technology's impact and effectiveness
- regular assessment of emerging technologies
- exploration and experimentation of Internet access
- developed awareness of technology consumption
- recurring cost-benefit analyses

Factual knowledge profits the learner only when it is turned into personal knowledge (Bettelheim 1989). Through careful inspection of historical and current technological expectations and a solid foundation of valid research we can create a sensible vision for moving forward.

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