

INSTRUCTIONAL AND INFORMATION TECHNOLOGY IN THE SCHOOL OF PHARMACY AT PURDUE

A Short History

by

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1. Introduction

With the current emphasis on the personal computer and high-speed networking tools, it is very easy to be lulled into the view that instructional technology did not exist before use of the personal computer was well established. Although the personal computer and high-speed networking tools undeniably accelerated interest in instructional technology in the mid-1990s, the School of Pharmacy was involved in instructional technology innovations as early as the 1970s. Because instructional technology is so intimately linked to information technology, we have chosen to treat these two areas together, which we will simply term "IT."

The purpose of this paper is to recount the history of IT in the School of Pharmacy in the philosophy that, if the School is to plan intelligently for where it wants to move in this area, it must be cognizant of where it has been. As might be expected, part of the progress in the School has been the result of deliberate planning efforts, and part of it has resulted from opportunistic efforts to take advantage of new technology as it has become available.

The elements of IT in the School, as they are everywhere, are remarkably diverse. Table 1 summarizes the areas of IT investment in the School covered in this paper, and these are offered with acknowledgment that some of these items are infrastructure, some are applications, and that there is considerable overlap among these areas.

TABLE 1. *Areas of Information and Instructional Technology in the School of Pharmacy*

Personal Computers
Networking Infrastructure
World-Wide Web Infrastructure and Use
Video Conferencing
Graphic Arts
Classroom Technology
Student Computer Laboratories
Continuing Education
Library
Purdue University Pharmacy
Student Registration and Advising
Business Services ¹

¹ Not covered in this paper.

2. Personal Computers and Related Hardware

The history of personal-computer use in the School begins in about 1980, when Professor Jack Yost of the Bionucleonics (BNUC) Department and Professor Marc Loudon of the Medicinal Chemistry (MDCH) Department each obtained a North Star computer with 64K of memory and a Z-80 microprocessor running the PC/M operating system, a forerunner of DOS. The most important application on these computers was undoubtedly WordStar®, one of the first “serious” word processors. (Text coding in WordStar® somewhat resembled that in modern HTML.) Dr. Yost’s computer was obtained primarily for research purposes, and Dr. Loudon’s was purchased by his publisher for use in writing the first edition of his textbook. It is amusing to contemplate the cost of this technology: a computer and daisy-wheel printer in 1980 cost \$8,000!

The secretarial staff of MDCH quickly learned about these initial acquisitions, and it did not take them long to see the efficiencies that word processing could bring to proposal preparation, which was the most time-consuming and stressful office task they had to perform. Ruth Ann Wiederhaft, the head secretary in MDCH, convinced John Cassady—if he needed convincing—that word processing would be a wise investment, and Ruth Ann saw to it that the technology was embraced by the office staff. The initial forays into office word processing were both North Star personal computers and software available at the University level, which was operated with “dumb” terminals via modem. This effort is noteworthy because it represented one of two efforts to network offices in the School to a central University server. (The other effort occurred in the Office of Student Services.) The networked word processor rapidly gave way to personal computers and printers, and the North Star machines eventually were replaced by IBM PCs with 8080 Microprocessors. Prof. Curt Ashendel developed a way to stream the WordStar® files developed in the PC/M operating system used on the North Star computers into the DOS environment of the IBM PC that made this evolution relatively seamless.

An amusing development occurred in the Dean’s office during this period. Dean Tyler was not particularly sympathetic to implementing these new technologies in the Dean’s office, but, in 1984, he left on sabbatical with clear instructions to Associate Deans George Spratto and Adelbert Knevel not to bother him “unless the building burned down.” The building didn’t burn down, and Tyler was not contacted, but Drs. Spratto and Knevel saw to it that the Dean’s office was fully equipped with the new technology; thus, it was then that office computing became a School venture.

As office computing continued to evolve, there was considerable interest in Macintosh computers because of their graphics capabilities. Dr. Loudon and Dr. Joe Stowell were forced onto the Macintosh platform because only this platform readily integrated structure drawing and vector-based graphics into the word-processor environment. This capability was important to MDCH faculty as well, and for this reason a number of MDCH offices were equipped with Macintoshes. The widespread adoption of the Windows operating system in the early to mid-1990s and the improvement of graphics capabilities in the Windows environment signaled the evolution of office computing to the Windows environment for the most part.

Today an inventory of the School's personal computer resources shows about 350 Windows-based PCs, 32 Macintoshes, and 3 Linux machines. In the College, there are currently about 460 Windows machines, 35 Macintoshes, and 5 Linux machines, as well as an additional 40 servers (mail servers, domain controllers, courseware servers, web servers, backup servers, and Unix machines used for molecular modeling) for which the College support staff is responsible. In all, College resources comprise about 560 desktop units. This represents an investment of well over \$0.5 million in desktop units alone, and does not include items such as printers, scanners, and the like, which are not inventoried.

As the inventory of computing hardware grew rapidly, so did maintenance issues. In March 2001 Jennifer Burnette was hired to assist Joe Rogers in managing the hardware issues in Pharmacy Technical Services. Jennifer has specialized in Windows-based hardware and software issues. As the result of a virus attack, the School had an emergency need for someone to help "clean up" a number of machines, and Michael Johnson was hired part-time to assist Jenette Tillotson, the network manager. Because the School needed additional help with hardware maintenance, Michael was retained and hired full time in May 2002. Michael also brought knowledge of the Macintosh hardware and software. A high demand from the School of Nursing for repair and software management services was met by asking Brett Nees in the Technical Services area to work part-time in hardware and software.

The lines between Technical Services and the Network Manager, predictably, have become increasingly blurred since these two employees were added and Brett Nees' responsibilities have been divided. At the time of this writing, Jennifer Burnette, Michael Johnson, and Brett Nees are all managed by the Technical Services Manager. The current administrative structure is potentially problematic, and it will be important to clarify the administration of this area. Problems have been avoided because of the good working relationships among people in these two areas.

Handheld devices (Personal Digital Assistants, or PDAs) have come into prominence in the last five years in the realm of pharmacy practice. The School has not had a PDA "hardware" initiative of any sort, but students do receive instruction (via guest speakers in the Therapeutics course as well as in Orientation to Clerkship) about the pharmaceutical databases that are available for them to use on their PDAs.

3. The Internet and Networking Infrastructure

As noted in Section 2, networking started tentatively with modem access in the main offices, and this spread to individual faculty offices. This required dedicated phone lines and modems, and the sluggishness of network services was frustrating. The MDCH Department hired an engineering student on a part-time basis who assisted the faculty and staff in setting up the appropriate technology.

Meanwhile, the Office of Student Services (OSS) was networked at the University level as early as 1980 with "dumb" terminals. The transformation to active online access began in 1990.

It is safe to say that high-speed internet on the campus began in the Schools of Engineering (ECN, the Engineering Computing Network) and migrated from there into PUC (the

Purdue University Computing Center). Eventually, the demand for high-speed internet grew so large that the University had to develop plans for a campus-wide backbone, and, by 1992, there was an active plan evolving for wiring the entire campus. It seemed, in the initial phases of this plan, that RHPH would be one of the last buildings to be “wired,” and faculty, particularly those in MDCH, felt that the School could not wait for the University. With the support of Dean Rutledge the MDCH faculty, and not long after, the Pharmacy Administration offices, including the Office of Student Services (OSS), were wired to the campus backbone. This infrastructure enhancement, which occurred in 1992, was made possible by the efforts of Dr. Joe Stowell, who at the time was on a partial appointment as the MDCH Director of Laboratories and partial appointment as a Research Scientists in Prof. Steve Byrn’s group. Dr. Stowell managed the scheduling of office wiring, the assignment of IP addresses, and the installation of routers, and did so without any additional compensation. (Dr. Stowell now is employed by the Chao Center.) Dr. Stowell’s efforts were for the most part quiet and “behind the scenes,” and his important efforts went largely unheralded.

By 1994, the campus backbone project was well under way, and the Dean’s office made a special appeal to PUCC to move RHPH ahead in the schedule. The general wiring of RHPH was completed in 1995, and the old routers and wiring were gradually phased out. (The old “drops” can still be seen in some offices.) As part of the campus wiring project, two rooms (RHPH 130D, formerly a physical plant area), and one on the fourth floor (RHPH 441, formerly Prof. Hem’s office in the IPPH office complex in RHPH 401) were assigned to PUCC for use as wiring closets.

Completion of the Campus Backbone wiring project brought the School of Pharmacy into the current “era” and set the stage for the internet capabilities the School enjoys today. During the 2002–2003 academic year, the campus wireless project brought wireless capability into the RHPH building, although reception is still not optimal at all locations. This capability will undoubtedly have major implications for Instructional Laboratories.

In the early 1990s, as the School expanded its operations in Indianapolis, the School looked toward technology to help cement the link between Indianapolis and West Lafayette. Videoteleconferencing capability was actively investigated, but the cost of T1 lines and videoteleconferencing equipment was prohibitive. By 2001, the infrastructure and equipment costs for videoteleconferencing had come down. At West Lafayette, the Dean’s Conference Room, two classrooms (RHPH 162 and 172), and three other conference rooms (RHPH G48, 552, and 554) were equipped for ISDN access; in 2001, RHPH 164 was remodeled as a distance-education classroom by the University and equipped with ISDN capability as well. A conference room in Purdue’s Wishard Hospital offices was also equipped with ISDN capability. Two portable (that is, “rollable”) videoteleconferencing units were purchased, one for West Lafayette and one for Wishard. This system is now used for faculty meetings, committee meetings, and seminars. Potentially this technology could link preceptor sites around the state, but this potential has not been realized in any significant way.

Throughout the 1994–2000 period, the rapid growth of IT infrastructure and the resulting management problems led to significant tensions between the various Schools at Purdue and PUCC. One of the major issues with PUCC was communication with the user base. In 1998, the Deans of all of the Purdue Schools asked for a review of PUCC. This review

resulted eventually in the resignation of John Steele as Director of PUCC, the hiring of Jim Bottum as Vice President for Information Technology and CIO, and the beginning of IT@P (Information Technology at Purdue) as the successor to PUCC. Among the major challenges facing IT@P are the development of IT policies on a diverse campus, and the implementation of the “OnePurdue” project, which is Purdue University’s four-year initiative to modernize its dated administrative computing applications—including those involving such areas as student services, human resources, research administration, and finance—into something that is easily accessible and web-based. Such an integrated system is called Enterprise Resource Planning (ERP).

Management of the Pharmacy IT systems, as noted above, started with Dr. Joseph Stowell. As the IT issues became more complex, the School appointed a Computer Committee, which consisted initially of Profs. Carol Post, Curt Ashendel, and Kinam Park, with Assoc. Dean Marc Loudon as Chair. This committee was in place by 1994. The office of the Associate Dean for Research and Graduate Programs (Dr. Marc Loudon) effectively became responsible for coordinating IT operations for the School.

Electronic mail services were initially provided by University servers (such as “Sage” and “Omni”), but these were rapidly overwhelmed by demand. This development, along with the rapid fall in prices for machines that could fulfill a role as e-mail servers, prompted the head of PUCC, John Steele, to develop a model for e-mail services in which *PUCC could provide “bare bones” services with limited storage capability, but the individual Schools would be responsible for providing additional services.* PUCC expected faculty and staff e-mail services to be migrated to the individual Schools, and PUCC would support e-mail services for students. Thus, in 1992, the School decided to develop its own e-mail services. Doug Couch, a Purdue electrical engineering technology graduate, was hired in 1992 and supervised the installation of the first mail server, a Windows NT system. Dr. Joe Stowell’s role in managing internet wiring and IP address deployment was mentioned previously. The use of the internet grew rapidly, and by 1995, “part-time” management of the School’s resources was no longer reasonable. The Computer Committee serving as search committee interviewed candidates for the School’s first salaried network manager. On recommendation of the committee, Mr. Steve Santy was hired in 1995. In addition to introducing the School’s first professional management of its network resources, Steve oversaw the installation of a new central server, a SUN-SPARC workstation dubbed “Sparky,” which handled both e-mail and web services. Steve left Pharmacy for a position in Management Information at Purdue in 1998. Woh-Meng Goh was hired as Pharmacy’s second network manager. One of Meng’s innovations was to place a Calendar Server into service. This allowed the scheduling of rooms and appointments over the web. Meng decided to continue his education elsewhere and left Purdue in 2001. He was replaced by Jenett Tillotson. Among the improvements brought about by Jenett were the introduction of a file server (“Rover”) and the introduction of IMAP mail service, as well as behind-the-scenes improvements such as backups, domain controllers, and other security enhancements. Jenett oversaw the development of an Acceptable-Use Policy for the School, which is given in Appendix 1. This policy was vetted with IT@P and was in place well before Purdue’s policy and is consistent with it. Jenett served also as an IT staff member in the Structure Group within the Department of Biological Sciences, and also provided services one day per week to the Campus NMR Center. During Jenett’s tenure, network security became an increasingly major issue. Jenett

resigned in 2004 to join the staff of Purdue's Envision Center, and Kristian Skjervold, who had been network manager for the City of Bloomington, joined the staff. Kristian and the other IT staff are implementing firewall protection for Pharmacy, something that the University has been unable to implement centrally. The Structure Group decided to hire a full-time person, but Kristian still provides IT services (approximately one day/week) to the Campus NMR Center.

Section 2 described the hiring of additional staff to manage hardware and software issues. These staff have spent increasing percentages of their time on network security issues, and for this reason a reorganization of Technical Services and Networking would appear to make sense.

It is important to understand that Pharmacy's Internet and Computer Services developed from a well-defined operational model from PUCC in which centralized services would be minimal. There has been some discussion about centralizing e-mail and other internet services for all units at Purdue within IT@P. Associate Dean Loudon met with IT@P staff, including Vice President Bottum, to discuss this possibility in early 2004. What became clear from this meeting is that IT@P can offer bare-bones e-mail service, but file servers and other enhancements would remain the province of the Schools. There was also talk of implementing Purdue-wide hardware maintenance and replacement contracts, but this is yet to occur. Even if such contracts become available, they will be likely be limited to the Windows platform. It is hard to envision that IT@P with its present resources can provide the level of service that the School of Pharmacy enjoys today. One of many examples of the advantages in the School's arrangement is the recent response to a general computer-virus attack on Purdue, which disabled most of the campus but not Pharmacy.

This is not to say that the School IT staff, which has a good working relationship with IT@P, does not look for ways in which central services can be utilized. For example, it is likely that the School will shortly move its domain-controller operation to IT@P, thus, saving the School the eventual cost for replacement of seven machines.

4. Planning for Instructional Technology

The School developed two Instructional Technology plans: one in 1989, and the other in 1996–1997. The 1989 Plan focused largely on the development of computer laboratories (the effect of which will be given in Section 5), and the 1997 plan was broader. The 1997 plan resulted from breakout sessions at a 1997 faculty retreat, and was presented to the faculty in the Fall of 1997. This plan is given in Appendix 2, and an executive summary presented to the faculty at a Fall 1997 faculty meeting is given in Appendix 3. The core of this plan became part of the 1998 Strategic Plan of the School.

What is striking is that much of the plan was accomplished. It is also worth noting that the availability of technology drove part of the plan, while the plan drove technology in other cases. For example, the (then) new availability of the world-wide web became a driver of the plan in the sense that faculty were asked to embrace this technology with a web page for every class. On the other hand, the desire of faculty to do certain things, such as prepare instructional CDs, develop computer laboratory exercises, etc., drove the purchase of new

technology. The important point, however, is that the plan was developed by a broad group of faculty and largely embraced once it was articulated.

It is also important to acknowledge the important role played by Dean Charles Rutledge during this period. Dean Rutledge was personally fascinated by the possibilities of instructional technology, and was a consistent enabler of these efforts throughout his tenure as Dean both by his personal encouragement, his development efforts, and his provision of strategically placed funds.

5. Instructional Computing Laboratories

Pharmacy was a leader in the instructional laboratory movement on the campus. The 1989 Instructional Computing Plan, although overly ambitious in its projections of computer-lab use, nevertheless made a strong case that an Instructional Computing Laboratory should be developed in Pharmacy. Nearly \$50,000 of development funds were raised with a Pharmacy initiative led by then Director of Development Bruce Hufford, and a room (RHPH 316, formerly a Bionucleonics laboratory) was set aside for this purpose. (See Appendix 4.) Pharmacy's commitment to instructional computing with both well-developed plans and considerable financial support led to the placement of one of the first three campus-wide PUCG Instructional Laboratories in Pharmacy in Fall 1990, the other two being in Physics and Agriculture Administration. This laboratory contained 12 Macintosh IIcx computers and 24 IBM PC 80386 machines, plus printers, networking hardware, and other items.

The management of this laboratory was a cooperative venture of PUCG and the School of Pharmacy in which PUCG provided a 20-hour graduate TA position for laboratory management. Anders Lund, a Ph. D. student in MDCH, first held this position, and his dedication and the cooperation of Joe Conte in PUCG played an important role in launching and running this laboratory. Eventually, PUCG developed laboratory manager positions, in which each of several professional managers is responsible for several laboratories.

Because the graduate program of the school had specialized computing needs, and because the instructional computing laboratories were often occupied with classes, a graduate-student laboratory (also open to undergraduates but not scheduled by IT@P) was opened in 1997 in RHPH 216. David Allen, whose office was also moved to RHPH 216, was charged with managing this laboratory. This laboratory housed the poster printer, a slidemaker, a scanner, a CD burner, several Macintosh and Windows computers with specialized software, Silicon Graphics workstations for use in molecular modeling, and both laptops and portable LCD projectors for checkout (reservable on the Calendar Server). Except for the poster printer, Silicon Graphics workstations, and LCD projectors, most of these other specialized functions have become routine desktop items for many and thus are no longer provided in centralized facilities. The poster printer and workstations will be relocated following renovation.

Pharmacy has used the RHPH 316 Instructional Computing Laboratory for certain courses and laboratory sections and continues to do so, but this use is far less than envisioned in the 1989 Instructional Technology Plan. One particular effort, however, is noteworthy. In 1995 an ambitious Mathematica-based Integrated Laboratory project was launched by Prof. Charles Pidgeon. The idea was that students would learn to use Mathematica as a central

computational tool, and that they would then apply this to many of their other courses, such as pharmacokinetics and statistics. This experiment was not successful, partly because of implementation issues, partly because the Mathematica “learning curve” is very steep for many undergraduates, and partly because no effort was made to propagate the use of this package as a computational tool into other courses. There are at least two lessons that can be drawn from this experience. The first is that the broad introduction of new technologies into the curriculum must be carefully planned. The second is that if the new technology is to be widely implemented across the curriculum, there should be a consensus of faculty support. There was considerable, although perhaps understandable, naïvety in thinking that the value of this technology would be self-evident.

An all-IBM-PC laboratory was opened in B012 JNSN (School of Nursing) in 1992. Eventually, the Macintosh computers were dropped from the RHPH laboratory, and both it and the JNSN laboratory are now operated as exclusively Windows environments.

If the number of computer laboratories around the campus today is any indication—59—the computer-laboratory initiative has been wildly successful. However, it seems reasonable to question, with wireless technology available almost everywhere, whether dedicated computer laboratories may not be reaching the end of their usefulness. Wireless technology has the capability of turning any classroom or laboratory within reach of the wireless signal into a computer laboratory provided that students have the computers and software, and computer laboratories tie up valuable space and resources that might be better used in other ways. On the other hand, instructional laboratories make computers and key software available to students who cannot (or will not) purchase them. The debating points are clear, and different institutions (or even different departments within the same institution) are thinking about whether to require students to own their own computers, who will pay for those computers, how printing will be managed, and who will bear the maintenance and service burden for these student computers.

6. The Computerized Classroom

Routine classroom instructional technology when the author arrived at Purdue in 1977 was limited to a blackboard, the ubiquitous overhead projector, and a plug-in for a Kodak Carousel Projector. The School’s Instructional Technology Plan of 1997 as well as Purdue’s general vision for instructional technology imagined classrooms routinely equipped with LCD projectors linked to computers, the computers themselves, CD and DVD players, and videotape players. PUCC and Space Management (SMAS) set about to make this vision a reality in the early 1990s. RHPH 172 (the main classroom in RHPH) was equipped with an LCD projector by 1994; RHPH 164, with Pharmacy’s cooperation, was remodeled as a distance-learning classroom in Summer 2001; and RHPH 162 was equipped with an LCD projector at about the same time. PUCC (later IT@P) and SMAS starting placing computer carts in classrooms in 1998, and today each RHPH classroom has either a cart or (in the case of RHPH 164) a computer console.

In 1998, then Assistant Professor Eric Barker of the Medicinal Chemistry and Molecular Pharmacology (MCMP) Department suggested that it would be helpful to students if streaming audio of each MCMP 407 and MCMP 408 class could be made available to

students via the world-wide web after class. Students, who would have available the professors' PowerPoint slides, could then review any class at leisure. Barker wrote a grant for a Purdue Multimedia Instructional Grant, and this was funded. With the key assistance of Mark Sharp in the Hook TV Studio, streaming audio was provided to students in 1999.

Prof. Marc Loudon became interested in this technology for use in MCMP 204 (Organic Chemistry), but expressed reservations to Mark Sharp about the value of audio-only, because Loudon used the blackboard and because structures are so important. Mark Sharp suggested the use of combined streaming audio and video in which the video component is picked up from a document camera; the document camera would in effect be the "blackboard." Another desirable feature of the camera is the ability to display molecular models and overheads. Another IT@P instructional grant was obtained for the document camera, and Loudon purchased the other hardware required with his Distinguished Professor funds. Mark Sharp developed software and supervised the hardware purchases and installation, first in RHPH 172, then later in LILY 1-105. When this technology was first presented to the faculty, several faculty suggested that "students won't come to class." However, the result of this technology is not a videotape of the class, but simply a pickup of anything placed on the document camera. It does not capture group work and has only limited value in capturing classroom dynamics. Classroom attendance has not declined since this technology was first offered. In the most recent survey, 50% of the students stated that they made use of the technology; those who used it, with few exceptions, said that they found it either "very useful" or "somewhat useful;" and there was no significant difference in the calculated grades between those who did and did not use the technology.

This shows that, at least for this technology, that not all students embrace it, although it appears to be useful for those who do. In determining the extent to which a technological innovation is mandated or presented as an option, it would seem that differences in learning styles are an issue to be reckoned with.

Wireless internet technology now makes many other technical innovations possible in the classroom, but the availability of individual student computers becomes central to these advances. This issue was discussed at the end of the previous section.

7. Graphic Arts

In 1992, Prof. Craig Marcus in the Department of Pharmacology and Toxicology conceived the idea that the School might develop sophisticated graphics for use classrooms and computer laboratories. At the same time, Dr. Marcus had the opportunity to pursue a subcontract from the University of Washington, an NIH-sponsored project entitled, "Essentials of Cell Biology." The deliverable was to be a CD with this title which would utilize animations to teach the subject. The School investigated whether there might be someone in the School of Technology who would be interested in working on this project, and David Allen, a recent graduate of the Computer Graphics Technology program, was suggested. David (then a student) was hired in 1992 on mostly soft money, as his salary was 75% paid by the Washington Cell Biology project.

Provided with a state-of-the-art Macintosh computer (because graphics capabilities on Windows machines were primitive), David brought the School's capability in this area from

zero to a modern, albeit one-person, graphics facility, and David is now the School's graphics resource. Starting with what is now Macromedia Director and its earlier congeners, David learned animation programs, three-dimensional modeling programs, and a host of other techniques that have a number of potential educational applications. At the same time, David provided support in this area for a number of faculty. He constructed a number of animations for Professor Peter Heinsteins for use in MDCH 304–305 (Biochemistry), and he developed a series of animations for organic chemistry with Prof. Loudon. The latter were marketed as a CD to Benjamin-Cummings Publishing Company to be sold along with the 3rd edition of Dr. Loudon's text, and all royalties on the CD flowed back to support the facility. A similar arrangement is in place for the 4th Edition of Dr. Loudon's text with Oxford University Press, for which David has completed over 30 animations. David was hired part-time to develop a CD-based animation package for a Purdue-wide recruiting brochure, "Unique Purdue," after then Academic Affairs Vice President Ringel saw a presentation by David at an academic review. Following some initial work by David, the new Director of Printing Services (later to become Marketing Communications) took over the project, and the "recruiting CD" was never produced. Purdue lost an opportunity to do something in the recruiting arena that at the time would have been truly innovative. Several other faculty in both Pharmacy and Nursing have made use of David's services for seminars, journal covers, and classroom support, and some have partially supported the facility from grants.

At the time the multimedia facility was started, preparing slide presentations was arduous and required a camera for recording PowerPoint slides on film. Slides then had to be developed by photographic services. David oversaw purchase of the slidemaker and its operation. Subsequently, with the introduction of LCD projectors into classrooms, it became possible to show PowerPoint presentations directly, and the slidemaker was phased out. Before classrooms were equipped with projectors, Pharmacy purchased two portable projectors (which are still operational), and these (along with a third purchased later) are still heavily used in seminar rooms and in presentations off campus. David oversaw the purchase and management of these. Before scanning was routine and scanners were cheap, David saw to the purchase, installation, and management of scanning facilities as well. David provided the capability to press CDs long before this became routine desktop technology. Another facility in which David played a key role is the purchase and management of the poster printer, which has been very useful for Pharm.D. students, faculty, and graduate students alike. The first printer was purchased with a Multimedia Grant from Purdue, and the second with development funds, although a proposal (written by David) was submitted to Purdue for this as well. David played a key and vital role in starting the world-wide web presence for the School of Pharmacy, as will be recounted in the next section. David is currently working with, and is partially supported by, Kara Duncan and the Nuclear Pharmacy Certificate Program.

David accomplished most of this after he was hired full-time in 1996 as Multimedia Director. The Washington CD was released in 1997. David continued his professional training on his own time, receiving his M.A. from Purdue in 2003.

8. The World-Wide Web (WWW)

Early in 1994 the PUCG sent out a general campus-wide invitation for people interested in working with the World Wide Web. On his own initiative, David Allen, who recognized immediately the potential of the WWW, attended this meeting and became excited about the educational possibilities of “the web.” He contacted Associate Dean Loudon to relate his findings and was encouraged to develop a web presence for the School of Pharmacy. Allen contacted PUCG in order to obtain hard drive space on the University web server (“Mozo”) for a School web site. He then gathered information from several School of Pharmacy-related brochures as well as departmental information and began to learn how to code this information for presentation in the web environment. From 1994 to 1996 he was constantly adding and updating text and graphic content on the web sites for the School. At the same time, Prof. Curt Ashendel developed specialized content for the MCMP Department and took over management of MCMP’s web page. After the employment of the first systems administrator (Steve Santy), the School purchased a new e-mail/web server, and Allen transferred all of the School’s web content to this server. He continued to expand the School’s web presence and services until 1999, when Allen’s recommendation that the School hire a dedicated webmaster was reinforced by an *ad hoc* committee that had been constituted to make recommendations about the School’s directions on the web. In 1999 the web maintenance duties were transferred over to Prof. Curtis L. Ashendel on a temporary basis until a full-time web administrator could be found. In 2001 Dr. Jeff Rattray was hired in as a full-time web administrator and is in that position to date.

One of the stipulations in the webmaster search was that a Pharmacy courseware system be developed that would be very easy to use. Many faculty were very dissatisfied with the early versions of WebCT (the system offered by the University), and Jeff Rattray had developed his own system in the Department of Food Science. After Jeff was hired his courseware system (YACS) was installed quickly and is widely used by many (though not all) Pharmacy faculty because it is so easy to learn. In MCMP 204, students have rated the web site (which uses Jeff’s system) very highly. The ready accessibility and ease of use of this system is one reason that course web sites have been developed for most of the Pharmacy courses. Jeff’s system is also used elsewhere on the campus, and a second version (YACS II) is complete.

By surveying incoming graduate students, Associate Dean Loudon found that Peterson’s Guide was being used very little as a source of information. The decision was made in 2000 to drop Peterson’s Guide, which saved about \$7500 per year, and put the resources into the web. Jeff led a redesign project in cooperation with students from the School of Technology that resulted in the current design of the School’s web page. Jeff has also overseen the upgrading of the courseware server and implementation of a backup system for the courseware server. Another of Jeff’s accomplishments was to implement a web-based student appointment system for the Office of Student Services on the calendar server. Jeff himself has also served as a “backup” for the Network Administrator.

Jeff also supports distance education efforts, and manages both Nursing and Health Science web pages. His salary is partially supported by these units, as well as by the Nuclear Pharmacy Certificate Program and by research grants for which he provides specialized

service. A future challenge is to develop a web-based data system that can be used to obtain faculty data such as awards and publications for annual reports and for special requests.

9. Continuing and Distance Education

Effective continuing and distance education has always been more reliant on technology for effective delivery than “ordinary” classes. Starting with the IHETS (Indiana Higher Education Telecommunications System) television network in 1970 and using today the latest web-based technologies, various distance-education and continuing-education activities illustrate the evolution of instructional technology.

Bill Jobe was the first Continuing Education (CE) Director and was involved in planning RHPH and the facility in Room 515 that provided coaxial TV cable throughout the building, which was completed in 1969. This was part of a University mandate to use the IHETS network, which would air broadcasting signals to sites throughout the state. The system was not used significantly by Bill. When Bill moved to the University of Texas, Jerry Blank became the Director of Continuing Education in 1973. Jerry’s training at the University of Wisconsin was in using audiotape programming in pharmacology for statewide CE. When Indiana went to mandatory CE in the mid-1970s, Jerry had about 2500 pharmacists at more than 20 sites throughout the state participating. The programs originated out of the audiovisual facilities in the FWA8 Building (now home to the School of Technology). They were broadcast over IHETS throughout the state and into Room 515, from which they were relayed to RHPH 172, which was nearly full for these offerings. Dick McCann was the first TV technician and worked out of RHPH 515; he coordinated all of the programming with IHETS.

IHETS gradually faded and the RHPH 515 studio became a storeroom, and then was subsumed into the NIH-sponsored renovation. Jerry Blank’s vision for CE was to develop videotape programming. He and Bob Bennett had worked together on several CE programs, and Bob was helping him with the fledgling nontraditional Pharm.D. program by videotaping the therapeutics course that Bennett coordinated and offering the tapes to pharmacists. Pharmacists were telling the School that they wanted more information on this new topic of Therapeutics. Bob Chalmers (Department Head of the Pharmacy Practice Department) allowed Bob Bennett move from clinical faculty to working with CE. Bob Bennett started recording video programs (called Current Topics in Therapeutics) which were shown at about 20 sites throughout the state for pharmacists’ CE. At the same time, Jerry and Bob were developing videotape programming for the various certificate programs, and Current Topics in Therapeutics was marketed nationally through Pharmat, a group associated with the University of Kansas. Because Dick McCann left the School, University Teleproductions was used, and all of this video was recorded at the FWA8 studios. Courses for the Nontraditional Doctor of Pharmacy Program (NTDPP) were subsequently videotaped there as well.

As the School’s video production effort grew, CE needed its own production facility because scheduling FWA8 was difficult. In 1988–89, SMAS and Dean Tyler were able to secure JNSN B19 as a dedicated studio in the Nursing Building. The Audio-Visual Control Room (JNSN B17) was also assigned to CE eventually. The family of August F. “Bud” Hook had

given the school about \$100,000 in memory of Bud. Dean Tyler provided this money to use for outfitting the new studio, and thus was born the Hook Telecommunications Center. The first Hook Director was Steve Burch from WLFI (local Channel 18). The Pharm.D. therapeutics classes all met in JNSN B19, where they were videotaped for use in the NTDPP. After 2-3 years, Steve left for a job with ABC in Los Angeles, and Nick Davis was hired from WLFI. Nick continued the operation for about two years before he left for a job in San Diego with ESPN. Dennis McCoy from WLFI was then hired. During this time, CE had numerous contracts that all involved video production. These efforts in the use of video continued into the mid-1990s.

Sadly, Jerry Blank passed away in December 1996. About a year before Jerry died, Dennis McCoy left for a job with American Drug Stores in Chicago and Mark Sharp from WLFI was hired. Mark brought the traditional production strengths to the job, but he also had great interest in the growing use of computer technology. Mark on his own has broadened the involvement of the Hook TV Studio across the School; his efforts to develop streaming audio and video were mentioned in Section 6, and he has also been involved in the production of web-based instruction for the Nuclear Pharmacy Certificate Program. Bob Bennett was named CE Director in 1997. He continued to use video for certificate program knowledge transfer and for programming in the NTDPP. Video options are still offered to pharmacists in Indiana who are taking NTDPP coursework, but now Mark Sharp digitizes the video, and it can be offered by downstreaming or by CD. This technology made it relatively easy to expand the program overseas. Thus, in 2002, a new international nontraditional Doctor of Pharmacy program in Dubai was initiated. Mark Sharp can upload the video to a password-protected site, and the coordinator in Dubai can download it and burn CDs for the students there, or Purdue can send a master set of CDs for copying. The School also uses videoconferencing technology for the program in Dubai. This has worked very well for conducting the Integrated Labs (402, 403, 404) with the students. Since a site in Riyadh was added, the School can connect to both Dubai and Riyadh simultaneously, and students at all locations can interact.

In 2001, certificate program participation dropped off rapidly as the shortage of pharmacists made it very difficult for pharmacists to travel to workshops. Bob Bennett decided to develop an internet-based certificate program that could teach knowledge and skills, help pharmacists develop caring attitudes, and allow the participating pharmacists to incorporate what they learn into their practice. The instructional design for this program was a true distance-learning effort. WebCT2 Campus Edition is used to provide the instructional resources to the pharmacists and for the "chat sessions." Real Player PresenterONE software is used for making video-CD lectures: lectures are videotaped in the Hook Studio and Mark Sharp digitizes them and produces a CD. PresenterONE is used to synchronize the video with the PowerPoint slides for the lecture. PresenterONE then creates a file that can be burned to a CD. This technology has worked very well for the pharmacists who have a wide variety of computer equipment and technical abilities. WebCT2 has worked well, but there is a concern that Vista (the new course software system) may cause serious problems because its more sophisticated hardware requirements. (That is, this hardware may not be immediately available to pharmacists in the field.) Bob Bennett is working now with Jeff Rattray to use Jeff's Courseware System to build the site for the Fall 2005 version of the Internet-based Diabetes Self-Management Certificate Program.

The Nuclear Pharmacy Certificate Program has taken full advantage of advancements in educational technology. This program was started in 1988–89 with money from Medi-Physics (now GE Healthcare) to help defray the costs. The first official program was rolled out in 1989. Originally, the program consisted of over 120 hours of videotaped instruction done in a distance setting, with an additional 80 hours of direct, hands-on content presented as a two-week, on-campus program. Anne Smith was the program's first director, but she left in January 2000 for personal health reasons. Kara Duncan (now Kara Duncan Weatherman), a Purdue graduate and formerly a Syncor employee, started teaching the program in May of 1999, and took over as the program's director July 2000. Kara began immediately to use WebCT for delivery of some of the training materials.

This program has seen a massive overhaul that involves use of technological innovations. All videotaped material was updated for content and was re-taped using digital technology and on-line computer editing with Mark Sharp's AVID editing system. Matt Regnier was hired as both a student and full time employee to develop animations and graphics to enhance both the videotape material and on-campus lecture materials, and now David Allen is serving that role. The new editing allows delivery of the program on both videotape and DVD. With Mark's and Matt's help, DVDs have been set up as chapters to allow students more flexibility in watching and reviewing the materials. Each student takes eight distance-based quizzes which previously had to be sent in for grading. Now each student takes an on-line quiz and a key is sent to both the preceptor and the student upon completion which has detailed explanations of *all* questions, not just the ones that were missed. The on-line system also allows the program to provide detailed information about clinical product-based information. This is not a requirement by the NRC, but it is an area about which most students would like additional information, so it is as part of the on-line training program.

Mark Sharp and Kara have developed a Palm-pilot based radiopharmaceutical database which has been piloted in the training programs. Currently, the program is considering releasing it for sale rather than giving it away.

All on-campus lectures have been converted to PowerPoint style to allow projection of the lecture material and to incorporate various graphics. The dose-drawing hoods in the laboratory have been outfitted with Apple I-Sight cameras and Macintosh computers. The program can now tape students while they are drawing materials in the hood so that students' techniques can be evaluated and their mistakes and problems can be analyzed

Duncan is planning some "virtual" laboratories that will focus on instrumentation and on product biodistribution. (Currently live rat models and a gamma camera are used to show biodistribution of radiopharmaceuticals). These can be used as part of the distance program to help solidify certain concepts in preparation for the on-campus, hands-on portion of the program. Duncan is also developing an on-line, interactive radiopharmaceutical guide that will include information about each product used, mechanism of action, preparation, troubleshooting and clinical applications. This will include interactive, on-line virtual exercises, videotape demonstrations, and clinical case examples. This also will be available on the web for assistance when working in the pharmacy.

The knowledge and efforts of Mark Sharp have been central to the implementation of these and other innovations. Mark received Purdue's "One Brick Higher" Award in 2004 for these

and other efforts that went “beyond the call of duty.” The work of Bob Bennett has also been recognized by a 2005 Purdue Distance Education Award.

10. The Purdue Pharmacy

The Purdue Pharmacy is rather unique in its use of technology. The first automated system was a QS-1 Pharmacy Management System installed in 1989. Continuous software and database updates are provided by QS-1. A hardware upgrade for “Y2K” was required in 1999. Another hardware upgrade was required in 2004 to fully automate prescription filing, credit-card transactions, and other aspects of the operation. This was paid for with \$19,000 in Instructional Computing funds and about the same amount of money from Purdue Pharmacy revenues. The Instructional Computing Grant resulted from a proposal from the director of the Pharmacy, Susan White.

The Purdue Pharmacy is a virtual private network, and it is not linked to the outside world for security reasons, although connection to specific insurance providers is possible. Data from the Pharmacy are fully backed up regularly onto a physical hard drive that is transported to and from a remote location.

11. The Pharmacy, Nursing, and Health Sciences Library

Information Technology in the Library System has been almost entirely a University initiative, but the libraries are such an important resource for the School that some review of Library IT seems appropriate. Dramatic improvements in library technology date from the appointment of Emily Mobley as Associate Director of Libraries in 1986, and then as Dean of Libraries in 1989. (Dean Mobley retired from this position in 2004.) The appointment of Vicki Killion as Pharmacy, Nursing, and Health Sciences Librarian in 1991 ensured that the PNHS Library would fully embrace the positive changes brought about by technology.

The effort to develop an electronic catalog began at Purdue when Libraries’ home-grown catalog system (PLUS) went online in 1986. It was available with a terminal in each library and via the campus network by the Unix “rlogin” command. It listed holdings added only during the previous 4-5 years, and searching was limited.

NOTIS (a libraries management software program) began in 1989. Searching was expanded to author, title, keywords, and subjects. At that time, Libraries began a retrospective conversion of all the holdings (i.e., added records for all books and journal titles.) In 1998, the Library system converted to a web-based catalog, and related improvements, such as on-line renewals, access to electronic journals and databases, and ready access to the catalogs of other libraries, followed.

The year 1995 signaled the beginning of a “quiet sea-change” in Libraries when the Ovid databases (such as MEDLINE) were acquired; these were the first of the end user-searchable online databases. Prior to that time, the databases were available only as floppy disks or CD-ROMs loaded onto workstations in each library. (The author remembers only too well a large desk drawer full of old *Current Contents* 5¼-inch floppy disks.) Alternatively, users could pay for searches that the librarians actually conducted through vendors. With the recurring Information Access funding, which was first made available to the Libraries in 1997–98, the number of online databases accessible directly to the users increased significantly.

The author took part in a University-wide “Journal Cancellation Project” in 1997. This potentially traumatic exercise turned out to signal a truly rapid movement towards the “electronic library.” Dean Mobley pledged that cuts in paper journals would be accompanied by a significant increase in the Library’s electronic resources that would make the “paper cuts” far less obtrusive than they seemed at the time. She made good on her pledge. One only need peruse the Library website to see how dramatically electronic resources, including electronic journal subscriptions, have increased since that time.

The “electronic library” raises new issues. Use of the PNHS Library “physical facility” for research purposes began to decrease dramatically in 2000–2001, about the time when the number of electronic journal subscriptions surged. This facility comprises significant space whose major use is student study space. The new Dean of Libraries, James Mullins, is beginning to talk of library consolidation. Such talk would have been heresy in 1999, but today one might well ask, “Why not?”

12. The Cost of Information Technology

It is reasonable to ask what IT resources have cost the School. The total cost of IT is virtually impossible to estimate with a reasonable effort, and even present expenditures are very difficult to assess, as they are spread over a variety of programs and sources. Nevertheless, the personnel expenditures in 2004 were approximately \$216,000, and the funding sources for these include the Dean’s Office (about 60–70%), the other departments and schools, individual research and educational projects, etc. Hardware expenditures that support only the networking, web/courseware, graphics, and related central operations are nonrecurring, but are approximately \$10,000 per year. This does not include, of course, replacement of desktop computers and printers for faculty and office staff.

Instructional Computing and Instructional Equipment grants from the Purdue Administration have played a significant role in hardware and software purchases. The Multimedia Instructional Grants have been mentioned in previous sections. These grants have provided an estimated \$30,000 per year since their inception in the mid 1990s.

One might also contemplate what *not* having these IT improvements would have cost the School, not only in dollars, but more specifically in its ability to do research and deliver its instructional programs effectively.

There are universities, or departments within universities, that have moved toward a requirement that all students own a computer. This can be the student’s responsibility, or the hardware can be provided by the academic unit and paid for by a tuition increment. Arguments can be made both for and against such a requirement. However, two points should be kept in mind should the School contemplate such a change.

- (1) Whose obligation will it be to provide maintenance (including replacements) for these additional 600–700 machines? If the School is to assume this responsibility, the present infrastructure—not only the number of people, but also the space—is wholly inadequate for such a massive maintenance operation. And, if not the School, who will be responsible?

- (2) What is the real purpose of such a strategy? Will (or can) technology drive pedagogical change in such a wholesale and positive manner that the expenditures can be justified?

There is no question that computers and related devices and the supporting infrastructure have brought about staggering increases in research and office productivity. But there is also little doubt that the advent of modern technology into the academy resulted in over-inflated promises of change in how education itself would be conducted. To some, the “new technology” means simply delivering lectures with PowerPoint. Thus, the fundamental method of teaching in many cases has not changed greatly, particularly in large universities. In education the medium is not the message, yet the medium has the potential for affecting how the message is delivered in new and innovative ways. Some of these have been described in this review. In contemplating the cost of major changes in educational technology, one must thus think about what it is that one is really buying.

Two papers by Stephen C. Ehrmann are particularly noteworthy in this context: “Implementing the Seven Principles: Technology as a Lever,” and “Asking the Right Questions: What Does Research Tell Us about Technology and Higher Learning?” (The first paper was the subject of the very first “Teaching with Technology” lecture given at Purdue in a university-wide venue.) The author believes that these papers are so important that they are attached to this review as Appendices 5 and 6. The central message of these two papers is that the value technology in education really lies in how it makes new methods of education possible.

A last point deals with assessment. When one goes to purchase a new car, one might think about buying the same make of automobile that one is presently driving, or one can make a change. Most people would not make such a major purchase without thinking about how the existing car has performed. The point is that assessment must be a part of any intelligent investment. The use of technology has been long on investment and short on assessment. The last recommendation of this paper is that a method of assessment be part and parcel of any major investment decision that is made on the use of technology.

We hope that this paper will help to stimulate discussion within the School and College on the future directions of Information and Instructional Technology.

Acknowledgments. The author would like to acknowledge the many faculty and staff who took the time to help recall the events recounted here. Particular acknowledgment goes to Joe Stowell, who, completely outside of the duties of his job, and asking nothing in return, helped start the School’s IT enterprise. We also acknowledge the support of former Dean Charles Rutledge, who provided significant moral and financial support for the School’s IT operations.

Appendix 1

School of Pharmacy Acceptable-Use Policy

ACCEPTABLE USE POLICY

for Computers and Networks in the Schools of Pharmacy, Nursing, and Health Sciences Purdue University

Introduction

Access to computers, services and networks owned by Purdue University is a privilege governed by certain regulations and restrictions. These include rules defined by the University and the schools as well as all applicable federal, state and local laws ([1],[2],[3]).

The schools pledge to provide their authorized users the best computer and network access possible and protect those resources as much as possible from unauthorized use and access. Without this protection, these resources could be victims of internal and external attacks that deny authorized access or result in the loss, dissemination, or compromise of data.

In return, the user agrees to abide by the regulations set forth in this Appropriate Use Policy. This means that the user agrees to behave responsibly according to the standards established by Purdue University and this document while using University systems and network resources.

Rights

Right to Use

All authorized users have the right to use computer and network resources within the guidelines set forth in this policy.

Right to Privacy

No user will be subject to unauthorized scanning or monitoring except as defined by this policy ([5]). Any request for access to logs or personal data must be mandated by the proper authority. Only individuals who are specifically authorized shall perform monitoring, and only the minimum amount of data necessary shall be collected. Data collected through monitoring shall be made accessible only to authorized individuals, who are responsible for maintaining its confidentiality. Content monitoring of network activity will not occur except as specifically defined below.

Allowance for Reasonable Monitoring ([5])

The system administrator reserves the right to monitor the usage of all network resources to ensure compliance with this policy, University policy, and federal, state and local laws. All users agree to this monitoring implicitly through use of the network resources. This includes:

- Logging and monitoring server usage and network traffic
- Accessing user data in the normal course of performing administration duties
- Monitoring resource usage to maintain functionality and efficiency
- Scanning, monitoring, and testing the network for security problems

Acceptable Uses

Users can use network and computer resources for University business that promotes the goals of the University. Network and computer resources are to be used in ways that do not unreasonably interfere with other users. Private use that does not interfere with the use of the resources for University business or violate laws or policies is also allowed.

All usage of computer systems at Purdue University must fall within the policy guidelines established by the University ([1],[2],[3]). Understanding and following these policies are the responsibility of each user.

Unacceptable Uses

Respect for Laws

Purdue users are expected to comply with copyright and intellectual property laws ([4]). Users will not use unlicensed copyrighted material, make illegal copies of copyrighted software, store such copies on University systems, or transmit such copies over University networks. Users will also not allow others to illegally use University licensed software. Proper usage and licensing of software is the responsibility of each individual user.

Respect for Other Users' Rights

Users will not use resources for non-University activities in ways that interfere with users performing University business.

For University business, users will not unreasonably use computer and network resources that interfere with other users' access to those resources. These resources include, but are not limited to, network services, bandwidth, and staff time.

Users will not conduct unauthorized scanning of computer network connected devices and systems ([5]). This scanning includes but is not limited to unauthorized electronic means to eavesdrop, collect, or disclose information about others.

Protection of Computer Resources

Users will not attempt or assist in attempts to gain unauthorized access to passwords, control information, services, computing resources, network resources, or computing facilities ([6]).

Users will not access any data without explicit permission from the owner of the data. This includes data that are not covered by federal, state or local laws ([2],[3]).

Users will not operate their computers in ways that risk the security of the network or other computer resources. This includes removing or preventing the installation of security measures, software or patches.

Protection of Other Users

Users will not use computer and network resources in ways that jeopardize, harass, intimidate, threaten, or otherwise harm other users, computers, or network resources including local users and users external to the University ([7]).

Notification of Proper Authorities

Users who become aware of any violation of this policy should notify the proper authorities. These authorities could include the network administrator, the head of the department, the Dean's office, university officials or the police.

Consequences

Violations of this policy will be reported to the Dean's office and other appropriate authorities. Non-compliance with this policy may also result in the loss of access to computer resources. The network administrators reserve the right to remove the network access and accounts of any user or computer that poses an immediate threat to other users. Said access will be denied until the immediate threat is remedied. The decision to permanently remove network or computer resource access and accounts will be left up to the individual departments and/or the Dean's office.

References

[1] Purdue Use of Electronic Mail Policy

<http://www.adpc.purdue.edu/VPBS/email.htm>

[2] HIPAA Policies and Procedures

http://www.itap.purdue.edu/security/policies/itap_hipaa_policy_procedure.pdf

[3] FERPA Policies and Procedures

<http://www.adpc.purdue.edu/VPBS/c-51.htm>

[4] Copyright Law

<http://www.copyright.gov/title17/circ92.pdf>

[5] Federal Wiretapping Law

http://www.eff.org/Privacy/Surveillance/200001_us_fed_wiretap_laws.html

[6] Indiana Computer Tampering Law

<http://www.ai.org/legislative/ic/code/title35/ar43/ch1.html#IC35-43-1-4>

[7] Indiana Intimidation and Harassment Law

<http://www.in.gov/legislative/ic/code/title35/ar45/ch2.html>

Appendix 2

School of Pharmacy Instructional Technology Plan of 1997

School of Pharmacy and Pharmacal Sciences

INSTRUCTIONAL TECHNOLOGY PLAN

Preamble

The use of technology in instruction is one of the many forces of change that educators face today. However, the use of technology is not an end in itself. While it cannot replace personal faculty-student interactions, technology can provide increased opportunities for other types of productive interactions between faculty and students, and can provide new ways for the rapid dissemination of information in a time when speed and efficiency are increasingly important. Technology can offer new and innovative ways of teaching and learning subject matter.

The use of new teaching technologies is appropriate when it is likely to increase student motivation, enhance student learning, and further the educational enterprise. Faculty, staff, and students must be willing to learn about new technologies, experiment with them, and embrace them where appropriate. This plan provides some expectations and requirements that should be met within a reasonable time frame (say, five years) in order for the School to adopt and use instructional technologies within its undergraduate- and graduate-education enterprises.

Faculty, Staff, and Student Capabilities

1. All students and faculty, as well as staff that interact with students and faculty, should be literate in using electronic mail and the world-wide web (WWW). Faculty should be able to assume that students will be literate in these technologies, and students should expect faculty to make use of these technologies as appropriate in their classes.
2. Startup instruction should be available for those students, faculty, and staff who need help becoming familiar with these tools. As part of this instruction, on-line documentation should be available for certain widely-used software and facilities, such as a network client, an electronic and/or pop-mail client, a world-wide web browser, Adobe Acrobat, the film recorder, and the LCD Projectors in RHPH 172 and RHPH 162. Software instruction should support all widely-used platforms.
3. All faculty and staff should have available, and should know how to use, a personal computer. All faculty and staff should have internet access at their desktop.
4. All students (both undergraduate and graduate) should have a personal computer or access to one through an instructional laboratory. Students who live off campus should understand that they will probably need a personal computer of their own and will be expected to subscribe to an internet provider that will enable them to access the world-wide web as well as their Purdue electronic mail account. (PUCC has currently arranged with GTE to provide for both staff and students a remote-access client at a nominal charge that can be added to the monthly telephone bill; more information can be obtained from GTE Internet Services at 1-800-363-8483.) Students should expect to purchase software sufficient to complete their assignments. Students should understand that instructional laboratories provided by Purdue probably will not meet all of the demand for personal computer access.
5. The School should maintain appropriate School-wide facilities, such as a film recorder, a computer for classroom use, a scanner, a CD-ROM presser, and the like, for use of faculty and students (as appropriate) in developing instructional materials.

6. The Multimedia Instructional Staff and Networking staff should be consolidated into a single area in which they can work together and conveniently supervise the equipment for which they are responsible.

Use of Technology in Courses

1. Faculty, TAs, and students should utilize electronic mail for communication; in particular, through a course-alias structure to be provided within 1–2 years by PUCC, faculty should plan to utilize electronic mail for communication with students in their courses.
2. The use of the world-wide web (WWW) should be maximized for instructional use. Instructors, with the help of the multimedia staff, should design and implement course home pages and use them for posting course materials such as reading and problem assignments, old examinations and answers, course syllabi, etc. Instructors posting large documents should become familiar with and utilize Acrobat technology to avoid the necessity of html coding.
3. Faculty should learn about, and make use of, new instructional technologies, such as interactive computing, molecular modeling, and animations, as well as the more sophisticated instructional capabilities of the WWW, where appropriate. Faculty should be provided with appropriate professional staff to assist in developing such capabilities, and, where appropriate, with enhanced TA support for early implementations of courses that utilize new technologies.
4. Faculty should be obligated to familiarize themselves with technologies used in courses prerequisite to the courses under their responsibility, and should endeavor, where appropriate, to continue and reinforce the use of these technologies in their own courses. For example, if *Mathematica* is required in the third-year integrated laboratory, faculty who teach in courses that follow this laboratory should continue to require students to use *Mathematica* for computational problems. Rudimentary instruction in these technologies should be available for faculty to come up to speed in these areas.
5. The School should implement video teleconferencing where appropriate to enhance communication of faculty and students at remote sites. In particular, classroom(s) and conference room(s) should be equipped for instruction by instructors at one site for students at another.

Use of Technology in Other Forms of Instruction

1. Currently Purdue faculty and students cannot access databases that are restricted to Purdue faculty and students only from computers whose addresses are not within the *purdue.edu* domain. This constitutes an information-access problem for faculty and students who work off-site. If this problem is not solved at the university level, a dial-in server and an appropriate number of phone lines should be provided at the School level to solve this problem for pharmacy staff and students who are off-site.
2. The WWW should be used for coordinating the experiential components of professional training.
3. The WWW should also be used for posting materials relevant to graduate education, such as departmental recruiting manuals, the Rules and Regulations manuals, and seminar announcements.

4. Graduate students should be encouraged to use new technologies in presenting seminars and dissertations, where appropriate, and should be provided assistance. Likewise, Pharm. D. students should be encouraged and assisted in the use of instructional technology in professional presentations.
5. The WWW, CD-ROMS, and other new instructional technologies should be explored for their possibilities in distance learning and continuing education.

Written by Associate Dean Marc Loudon

Adopted by the Faculty, September 1997

Appendix 3

School of Pharmacy Instructional Technology Plan of 1997—Summary

Instructional Technology Plan

for the

School of Pharmacy and Pharmacal Sciences

Goals

Facilitate student access to course information: not only handouts and old exams, but also animations, demonstrations, sample quizzes with immediate feedback, and other non-traditional information.

Facilitate two-way communication between instructor and student.

Engage students in unique computer-based exercises that free students from calculational drudgery and allow the students to explore efficiently the quantitative aspects of concepts and principles.

Develop student facility, comfort level, and creative thinking about computer applications.

Enhance student learning and motivation for learning.

Technology is not an end in itself; it should be used when it is likely to enhance student learning, open new educational possibilities, and increase student enthusiasm.

Some experiments with technology will not be successful; the possibility of failure should not deter well-considered efforts to use instructional technology.

University, School, and Department Responsibilities

Faculty will be given assistance in learning new technologies.

The University, School, and Departments (as appropriate) will maintain infrastructure.

Computer/networking maintenance support

Design support for web pages and instructional modules. (Purdue now offers Instructional Computing grants.) The faculty should usually exercise a conceptual rather than a hands-on developmental role in designing new instructional materials.

Shared equipment: film recorder, scanner, CD-ROM presser

Faculty office computers and instructional computing laboratories.

Faculty and student access to Purdue-only databases from remote sites.

Development of videoteleconferencing facilities when and where feasible.

Faculty will be given release time for developing truly innovative uses of technology in their courses.

Faculty Responsibilities

Faculty *and staff* should know how to use a personal computer.

Faculty *and staff* should be literate in the use of electronic mail and the world-wide web.

Faculty should make use of these technologies in their teaching. (Students *like* this feature.) All courses should have home pages. Instructors who wish to post large documents should become familiar with Adobe Acrobat technology.

Faculty should familiarize themselves with new instructional technologies and explore their use in their classes where appropriate.

Faculty and staff should utilize the capabilities of the world-wide web for coordinating experiential education.

Faculty should familiarize themselves with technologies utilized by prerequisite courses, and should and should endeavor, where appropriate, to reinforce the understanding and use of these technologies in their courses.

Faculty and staff should use new technologies (World-Wide Web, CD-ROMs), where appropriate, for distance learning and continuing education.

Student Responsibilities

Students should own or have available a personal computer and should know how to use it.

Students should realize that the Instructional Computing Laboratories will in all probability not be able to meet the need for computers.

Students should procure internet access through a subscription service, if necessary, and should know how to use it.

Students should know how to use electronic mail and the world-wide web.

Graduate and advanced professional students should be encouraged to use new technologies in their coursework, in their professional presentations, and (if appropriate) in presentation of research results—even theses.

Appendix 4

Documents Related to the Establishment of the RHPH Instructional Computing Laboratory

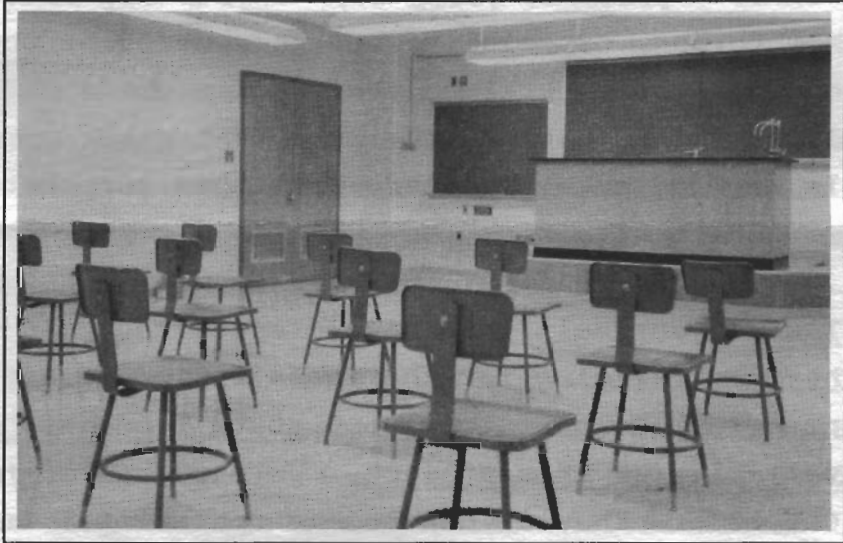
1. Development literature soliciting funds for the new laboratory
(Bruce Hufford, Development Director)
2. The document officially establishing RHPH 316 as a PUCC Instructional Computing Lab. (The annotations were made by the Dr. Loudon prior to further discussions with PUCC. All questions were resolved satisfactorily.)



FROM THE DEAN'S DESK

Charles O. Rutledge

What's wrong
with this
picture?



Pharmacy Student Computer Lab - Room 316

Remember the popular television commercial that posed that important question - "Where's the beef?" Our pharmacy students are asking a similar question--"Where are the computers?"

You and I realize the necessity of computer literacy in our society, especially as it applies to our profession. This past year, when the faculty developed a strategic plan for the School of Pharmacy for the 1990's and beyond, training students to understand and use computers became a high priority. We want our students to be proficient in fundamental computer skills, so they

can be as productive as possible when they begin their professional careers.

It's difficult for me to tell our pharmacy students that personal computers are not available for them to use, especially when they describe the well equipped computer labs they had in grade school and high school. They know that other schools at Purdue have already developed computer labs for their students.

I need your help! We have cleared Room 316 in the Pharmacy Building for the installation of a student computer laboratory, but state funds are not available for this project. We must raise \$265,000 before the lab can become operational for the 1989-90 school year.

The Pharmacy Student Computer Lab will accommodate up to 40 students at a time. Equipment will include 40 personal computers (25 IBM compatible and 15 Macintosh), 20 dot matrix printers, 4 modems, and 2 laser jet printers.

Students will become competent in using word processing, data base and spread sheet software. They will also have the opportunity to use packages for statistical analysis, desk top publishing, communications, graphics, programming languages, information retrieval and pharmacokinetic analysis.

An experienced computer instructor will be available on-site to direct our students in their computer learning.

Will you help? Your gift, regardless how large or small, is needed. If you are an employee of a business that would benefit from hiring pharmacy students with good computer skills, please share this opportunity with the proper person in your company and ask the company to give generously in addition to your personal gift.

We want to recognize individuals and companies who give generous support to the Pharmacy Student Computer Lab. A permanent plaque will be mounted in the computer lab naming those individuals and companies who contribute \$500 or more. In addition, we will mount an engraved plate bearing your name (or company name) to each piece of equipment that you fully fund. What a fitting way to let present and future students know, that you (or your company) are interested in continuing the reputation of excellence long associated with the School of Pharmacy.

Current equipment prices are:

IBM compatible computer @ \$2,000

Macintosh computer @ \$3,500

Dot matrix printer @ \$1,000

Laser printer @ \$4,000

*Please
Consider!*

This is a marvelous opportunity to help your school accomplish a major project that will pay great dividends to our students and to those who hire them.

If you act now your gift can still qualify for a deduction on your 1988 federal income tax return. Indiana residents and corporations can receive an Indiana tax CREDIT for up to 50% of the amount of the gift. Please call our pharmacy development office (317) 494-1370 if you want more information about this project or the tax benefits.

Next year when students ask me about computers, I will look forward to showing them our modern facility, and will point with pride and gratitude to you and your fellow alumni who made the Pharmacy Student Computer Lab possible.

Thanks for investing in our students!

Charles O. Rutledge

Instructional Computing Laboratory

Pharmacy - Room 316

Prepared by Tom Putnam
March 28, 1990

Concerns:
Off-hour supervision
Supplies - cartridges,
paper,
diskettes, etc
Phone for TA
Can people walk in
when classes are in
session?
Software

Introduction

This document provides an overview of the plans for the shared instructional computing laboratory being developed in the Pharmacy building (RHPH 316). The laboratory is intended to serve multiple uses and multiple departments. In particular, the initial uses include serving additional students taking CS 110, especially Pharmacy students who will henceforth be required to take the course.

The laboratory will be divided into two areas separated by a partition:
24 MS-DOS stations
11 Macintosh IICx stations

The MS-DOS stations will be used for CS110 as well as other classes in Pharmacy, English, and other departments. Many of these classes will have scheduled meeting times in the lab. The Macintosh stations could be scheduled by small classes but are more likely to be used for open lab assignments and for instructional development.

Two print/file servers are included, one for the MS-DOS machines and one for the Macs. Each server will support an Apple Laserwriter IINT for printing. There is also an instructor's station in the MS-DOS side of the lab. An overhead projector with a Kodak Datashow is included.

In addition to the local area networking which ties each student station to a server, all of the systems will be connected to the campus backbone network. The MS-DOS machines will each have an Ethernet adapter which serves the dual purpose of connecting to the server and the Internet. The Macs will connect to the Internet through a Kinetics FastPath gateway. ISN connections will be provided from 5 of the MS-DOS machines to access the BRS Medline information retrieval service.

Laboratory Supervision

PUCC has established a position and appointed Dr. Joe Conte as *Supervisor of Instructional Laboratories* within our User Services group. A half-time (nominally graduate student) laboratory coordinator will report to Dr. Conte as the person responsible for day-to-day support of the laboratory in Pharmacy. We will be seeking a coordinator whose background is related to Pharmacy if possible. We would prefer to find a desk or other office space for this person in the Pharmacy building near the laboratory. Other arrangements are possible, such as a similar level of PUCC financial support for a Pharmacy person who also has other duties.

The laboratory coordinator will be responsible for installation and checkout of new instructional software and effecting operating policies and procedures for the lab (such as backups, virus checking, and so forth).

Each instructor using the lab will be expected to supervise the lab while it is being used by his/her students. This includes open times during the evenings and weekends if such times are deemed desirable. The lab must be closed and locked (to prevent theft) when it is not supervised.

MS-DOS Laboratory Configuration

There are 24 student stations, 1 server, and 1 instructors station. The student and instructor stations will include:

- 16 MHz 80386SX processor
- 2 MB RAM
- 30-40 MB hard disk
- 16-bit VGA video adapter and color monitor
- 1.44 MB 3.5" diskette drive
- Mouse
- Ethernet Adapter

The server will utilize a similar processor with 6 MB RAM, monochrome monitor, and 80 MB disk. An Apple Laserwriter IINT will be connected to the server.

All systems will use MS-DOS and Novell Netware (286) with packet driver interface to the Ethernet. Student and instructor stations will also be able to use NCSA Telnet to achieve Internet access.

Software to be provided by PUCC will include:

- Microsoft Word
- Framework III (for CS 110)
- Microsoft Quick Basic

Macintosh Laboratory Configuration

There are 11 student stations and 1 server. The student stations will include:

- Apple Macintosh IICx
- 5 MB RAM
- 40 MB hard disk
- 8-bit video adapter and color monitor
- 1.44 MB 3.5" diskette drive
- Mouse

The server will utilize a Mac SE/30 with 4 MB RAM and 240 MB disk. An Apple Laserwriter IINT will be connected to the localtalk network. A Kinetics FastPath gateway will link the Macs and the Laserwriter to the Internet. Appleshare File Server and Print Server software is included.

Software to be provided by PUCC will include:

- Microsoft Word
- Hypercard

Appendix 5

Arthur W. Chickering and Stephen C. Ehrmann, "Implementing the Seven Principles: Technology as a Lever," which originally appeared in

AAHE Bulletin (1996), October Issue, pp. 3–6

(This paper contains some web links which are not active in the PDF version.)

IMPLEMENTING THE SEVEN PRINCIPLES: Technology as Lever

by Arthur W. Chickering and Stephen C. Ehrmann

*Citation: The article originally appeared in print as:
Chickering, Arthur and Stephen C. Ehrmann (1996), "Implementing the Seven Principles:
Technology as Lever," AAHE Bulletin, October, pp. 3-6.*

See the bottom of this article for updates, a link to a new and extensive library of ideas for using technology to implement the seven principles, a recorded interview with Chickering and Ehrmann about this history of the seven principles and their relevance to technology use, and our request that you share more such examples of technology use.

In March 1987, the AAHE Bulletin first published “Seven Principles for Good Practice in Undergraduate Education.” With support from Lilly Endowment, that document was followed by a Seven Principles Faculty Inventory and an Institutional Inventory (Johnson Foundation, 1989) and by a Student Inventory (1990). The Principles, created by Art Chickering and Zelda Gamson with help from higher education colleagues, AAHE, and the Education Commission of the States, with support from the Johnson Foundation, distilled findings from decades of research on the undergraduate experience.

Several hundred thousand copies of the Principles and Inventories have been distributed on two- and four-year campuses in the United States and Canada. (Copies are available at cost from the Seven Principles Resource Center, Winona State University, PO Box 5838, Winona, MN 55987-5838; ph 507/457-5020.) — Eds.

Since the Seven Principles of Good Practice were created in 1987, new communication and information technologies have become major resources for teaching and learning in higher education. If the power of the new technologies is to be fully realized, they should be employed in ways consistent with the Seven Principles. Such technologies are tools with multiple capabilities; it is misleading to make assertions like “Microcomputers will empower students” because that is only one way in which computers might be used.

Any given instructional strategy can be supported by a number of contrasting technologies (old and new), just as any given technology might support different instructional strategies. But for any given instructional strategy, some technologies are better than others: Better to turn a screw with a screwdriver than a hammer — a dime may also do the trick, but a screwdriver is usually better.

This essay, then, describes some of the most cost-effective and appropriate ways to use computers, video, and telecommunications technologies to advance the Seven Principles.

1 Good Practice Encourages Contacts between Students and Faculty

Frequent student-faculty contact in and out of class is a most important factor in student motivation and involvement. Faculty concern helps students get through rough times and keep on

working. Knowing a few faculty members well enhances students' intellectual commitment and encourages them to think about their own values and plans.

Communication technologies that increase access to faculty members, help them share useful resources, and provide for joint problem solving and shared learning can usefully augment face-to-face contact in and outside of class meetings. By putting in place a more "distant" source of information and guidance for students, such technologies can strengthen faculty interactions with all students, but especially with shy students who are reluctant to ask questions or challenge the teacher directly. It is often easier to discuss values and personal concerns in writing than orally, since inadvertent or ambiguous nonverbal signals are not so dominant. As the number of commuting part-time students and adult learners increases, technologies provide opportunities for interaction not possible when students come to class and leave soon afterward to meet work or family responsibilities.

The biggest success story in this realm has been that of time-delayed (asynchronous) communication. Traditionally, time-delayed communication took place in education through the exchange of homework, either in class or by mail (for more distant learners). Such time-delayed exchange was often a rather impoverished form of conversation, typically limited to three conversational turns:

1. The instructor poses a question (a task).
2. The student responds (with homework).
3. The instructor responds some time later with comments and a grade.

The conversation often ends there; by the time the grade or comment is received, the course and student are off on new topics.

Now, however, electronic mail, computer conferencing, and the World Wide Web increase opportunities for students and faculty to converse and exchange work much more speedily than before, and more thoughtfully and "safely" than when confronting each other in a classroom or faculty office. Total communication increases and, for many students, the result seems more intimate, protected, and convenient than the more intimidating demands of face-to-face communication with faculty.

Professor Norman Coombs reports that, after twelve years of teaching black history at the Rochester Institute of Technology, the first time he used email was the first time a student asked what he, a white man, was doing teaching black history. The literature is full of stories of students from different cultures opening up in and out of class when email became available. Communication also is eased when student or instructor (or both) is not a native speaker of English; each party can take a bit more time to interpret what has been said and compose a response. With the new media, participation and contribution from diverse students become more equitable and widespread.

2. Good Practice Develops Reciprocity and Cooperation among Students

Learning is enhanced when it is more like a team effort than a solo race. Good learning, like good work, is collaborative and social, not competitive and isolated. Working with others often increases involvement in learning. Sharing one's ideas and responding to others' improves thinking and deepens understanding.

The increased opportunities for interaction with faculty noted above apply equally to communication with fellow students. Study groups, collaborative learning, group problem solving, and discussion of assignments can all be dramatically strengthened through communication tools that facilitate such activity.

The extent to which computer-based tools encourage spontaneous student collaboration was one of the earliest surprises about computers. A clear advantage of email for today's busy commuting students is that it opens up communication among classmates even when they are not physically together.

For example: One of us, attempting to learn to navigate the Web, took a course taught entirely by a combination of televised class sessions (seen live or taped) and by work on a course Web page. The hundred students in the course included persons in Germany and the Washington, DC, area.

Learning teams helped themselves "learn the plumbing" and solve problems. These team members never met face-to-face. But they completed and exchanged Myers-Briggs Type Inventories, surveys of their prior experience and level of computer expertise, and brief personal introductions. This material helped teammates size one another up initially; team interactions then built working relationships and encouraged acquaintanceship. This kind of "collaborative learning" would be all but impossible without the presence of the media we were learning about and with.

3. Good Practice Uses Active Learning Techniques

Learning is not a spectator sport. Students do not learn much just sitting in classes listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write reflectively about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves.

The range of technologies that encourage active learning is staggering. Many fall into one of three categories: tools and resources for learning by doing, time-delayed exchange, and real-time conversation. Today, all three usually can be supported with "worldware," i.e., software (such as word processors) originally developed for other purposes but now used for instruction, too.

We've already discussed communication tools, so here we will focus on learning by doing. Apprentice-like learning has been supported by many traditional technologies: research libraries, laboratories, art and architectural studios, athletic fields. Newer technologies now can enrich and expand these opportunities. For example:

- Supporting apprentice-like activities in fields that themselves require the use of technology as a tool, such as statistical research and computer-based music, or use of the Internet to gather information not available in the local library.
- Simulating techniques that do not themselves require computers, such as helping chemistry students develop and practice research skills in “dry” simulated laboratories before they use the riskier, more expensive real equipment.
- Helping students develop insight. For example, students can be asked to design a radio antenna. Simulation software displays not only their design but the ordinarily invisible electromagnetic waves the antenna would emit. Students change their designs and instantly see resulting changes in the waves. The aim of this exercise is not to design antennae but to build deeper understanding of electromagnetism.

4. Good Practice Gives Prompt Feedback

Knowing what you know and don't know focuses your learning. In getting started, students need help in assessing their existing knowledge and competence. Then, in classes, students need frequent opportunities to perform and receive feedback on their performance. At various points during college, and at its end, students need chances to reflect on what they have learned, what they still need to know, and how they might assess themselves.

The ways in which new technologies can provide feedback are many — sometimes obvious, sometimes more subtle. We already have talked about the use of email for supporting person-to-person feedback, for example, and the feedback inherent in simulations. Computers also have a growing role in recording and analyzing personal and professional performances. Teachers can use technology to provide critical observations for an apprentice; for example, video to help a novice teacher, actor, or athlete critique his or her own performance. Faculty (or other students) can react to a writer's draft using the “hidden text” option available in word processors: Turned on, the “hidden” comments spring up; turned off, the comments recede and the writer's prized work is again free of “red ink.”

As we move toward portfolio evaluation strategies, computers can provide rich storage and easy access to student products and performances. Computers can keep track of early efforts, so instructors and students can see the extent to which later efforts demonstrate gains in knowledge, competence, or other valued outcomes. Performances that are time-consuming and expensive to record and evaluate — such as leadership skills, group process management, or multicultural interactions — can be elicited and stored, not only for ongoing critique but also as a record of growing capacity.

5. Good Practice Emphasizes Time on Task

Time plus energy equals learning. Learning to use one's time well is critical for students and professionals alike. Allocating realistic amounts of time means effective learning for students and effective teaching for faculty.

New technologies can dramatically improve time on task for students and faculty members. Some years ago a faculty member told one of us that he used technology to “steal students' beer

time,” attracting them to work on course projects instead of goofing off. Technology also can increase time on task by making studying more efficient. Teaching strategies that help students learn at home or work can save hours otherwise spent commuting to and from campus, finding parking places, and so on. Time efficiency also increases when interactions between teacher and students, and among students, fit busy work and home schedules. And students and faculty alike make better use of time when they can get access to important resources for learning without trudging to the library, flipping through card files, scanning microfilm and microfiche, and scrounging the reference room.

For faculty members interested in classroom research, computers can record student participation and interaction and help document student time on task, especially as related to student performance.

6. Good Practice Communicates High Expectations

Expect more and you will get it. High expectations are important for everyone — for the poorly prepared, for those unwilling to exert themselves, and for the bright and well motivated. Expecting students to perform well becomes a self-fulfilling prophecy.

New technologies can communicate high expectations explicitly and efficiently. Significant real-life problems, conflicting perspectives, or paradoxical data sets can set powerful learning challenges that drive students to not only acquire information but sharpen their cognitive skills of analysis, synthesis, application, and evaluation.

Many faculty report that students feel stimulated by knowing their finished work will be “published” on the World Wide Web. With technology, criteria for evaluating products and performances can be more clearly articulated by the teacher, or generated collaboratively with students. General criteria can be illustrated with samples of excellent, average, mediocre, and faulty performance. These samples can be shared and modified easily. They provide a basis for peer evaluation, so learning teams can help everyone succeed.

7. Good Practice Respects Diverse Talents and Ways of Learning

Many roads lead to learning. Different students bring different talents and styles to college. Brilliant students in a seminar might be all thumbs in a lab or studio; students rich in hands-on experience may not do so well with theory. Students need opportunities to show their talents and learn in ways that work for them. Then they can be pushed to learn in new ways that do not come so easily.

Technological resources can ask for different methods of learning through powerful visuals and well-organized print; through direct, vicarious, and virtual experiences; and through tasks requiring analysis, synthesis, and evaluation, with applications to real-life situations. They can encourage self-reflection and self-evaluation. They can drive collaboration and group problem solving. Technologies can help students learn in ways they find most effective and broaden their repertoires for learning. They can supply structure for students who need it and leave assignments more open-ended for students who don't. Fast, bright students can move quickly

through materials they master easily and go on to more difficult tasks; slower students can take more time and get more feedback and direct help from teachers and fellow students. Aided by technologies, students with similar motives and talents can work in cohort study groups without constraints of time and place.

Evaluation and the Seven Principles

How are we to know whether given technologies are as useful in promoting the Seven Principles and learning as this article claims? One approach is to look and see, which is the aim of the “[Flashlight Project](#),” a three-year effort begun by the Annenberg/CPB Project to develop and share evaluation procedures. The Flashlight Project is developing a suite of evaluation tools that any campus can use to monitor the usefulness of technology in implementing the Seven Principles and the impacts of such changes on learning outcomes (e.g., the student’s ability to apply what was learned in the academic program) and on access (e.g., whether hoped-for gains in time on task and retention are saving money for the institution and its funders).

[For more about the Flashlight Program, see [Stephen Ehrmann’s “Asking the Right Questions: What Does Research Tell Us About Technology and Higher Learning?”](#) in the March/April 1995 Change.]

Technology Is Not Enough

The Seven Principles cannot be implemented by technophiles alone, or even by faculty alone. Students need to become familiar with the Principles and be more assertive with respect to their own learning. When confronted with teaching strategies and course requirements that use technologies in ways contrary to the Principles, students should, if possible, move to alternatives that serve them better. If teaching focuses simply on memorizing and regurgitating prepackaged information, whether delivered by a faculty lecture or computer, students should reach for a different course, search out additional resources or complementary experiences, establish their own study groups, or go to the professor for more substantial activities and feedback.

Faculty members who already work with students in ways consistent with the Principles need to be tough-minded about the software- and technology-assisted interactions they create and buy into. They need to eschew materials that are simply didactic, and search instead for those that are interactive, problem oriented, relevant to real-world issues, and that evoke student motivation.

Institutional policies concerning learning resources and technology support need to give high priority to user-friendly hardware, software, and communication vehicles that help faculty and students use technologies efficiently and effectively. Investments in professional development for faculty members, plus training and computer lab assistance for students, will be necessary if learning potentials are to be realized.

Finally, it is appropriate for legislators and other benefactors to ask whether institutions are striving to improve educational practice consistent with the Seven Principles. Much depends on the answer.

Note: This article draws on Arthur Chickering's participation in "The Future of Face-to-Face and Distance Learning in Post-Secondary Education," a workgroup chaired by W.L. Renwick as part of a larger effort examining The Future of Post-Secondary Education and the Role of Information and Communication Technology: A Clarifying Report, carried out by the Center for Educational Research and Innovation, Organization for Economic Cooperation and Development. Paris: 1993, 1994.

The Flashlight Program is now a part of the non-profit Teaching, Learning, and Technology Group. The TLT Group provides a range of services to help faculty, their institutions, and their programs make more sensible use of technology. About 250 colleges, universities, state boards, and multi-institution projects now subscribe to TLT Group tools or services.

New Ideas, and Additional Reading

Stephen C. Ehrmann
Updated October, 2003

Since 1996, when Art Chickering and I wrote the preceding article, much has changed but much has remained the same. For example, offerings in distance education have exploded. However, these same seven principles, and these seven kinds of technology use, seem equally important for all kinds of learners (and faculty) in all kinds of situations. Whether students come to campus every day or not at all, for example, student interaction can be increased and improved by some of the same online approaches.

The TLT Group is creating a rather large library of teaching ideas, sorted by the seven principles. It's a successor to, and complement to, the article you've just read. There's a smaller, public version of this article and a larger version plus other resources that's available only to the 300+ institutions that subscribe to the TLT/Flashlight Program. To see this TLT/Seven Principles library of teaching ideas, click here.

My colleague Steve Gilbert has pointed out another way to array these practices for advancing the seven principles: by how hard or easy they are for faculty to learn quickly and for the institution to support. He has spotlighted low threshold activities: uses of technology that are (for that faculty member in that institution at that time) quite easy to learn (in seconds or minutes) and easy for the institution to support (even if all faculty want to use technology in that way.) This Web page contains a growing list of references and materials about such activities. We may soon begin development of a library of low threshold activities for each of the seven principles and, if so, we'll need your help, so watch this space!

Not all important uses of technology are low threshold for the institution or the faculty. Some are quite promising but require substantial reorganization and rethinking of faculty roles. Some of these ideas require major change in the organization of individual courses (e.g., the BioCalc course for teaching calculus to biology students at the University of Illinois, Urbana Champaign). Others, even more ambitious, are conscious efforts to change a major, a whole

institution, or a system. Examples include distance learning programs, problem-based learning for a whole major, institution-wide efforts to improve information literacy and skills of inquiry, and redesign of large enrollment courses to improve learning and control costs per student. Technology advocates have been promising for many decades that such major improvements were imminent. Although some of these ideas have succeeded and have made permanent, national changes in higher learning, too many others have flowered briefly and withered, or never flowered at all. Often the very technology that helped spark interest in these ideas was blamed some years later as inadequate, and the reason the innovation had failed. In “Using Technology to Make Large-Scale Improvements in The Outcomes of Higher Education: Learning From Past Mistakes,” I suggested that we’ve failed repeatedly because we’ve made the same mistakes repeatedly, in the 1970s, 1980s, 1990s, and today. Its time to learn from those errors. This article draws on past experience to suggest a five part strategy for using technology to make valuable, large scale, lasting improvements in who can learn and what they have learned by the time they complete a program in higher education.

Is it true that research has never proved that technology improves learning? I tried to summarize some of the findings that have had the greatest influence on my own thinking in the 1995 article, “Asking the Right Question: What Does Research Tell Us about Technology and Higher Learning?” in *Change. The Magazine of Higher Learning*, XXVII:2 (March/April), pp. 20-27. This essay gives a brief overview of the evaluation literature on teaching, learning, technology and costs.

Appendix 6

Stephen C. Ehrmann, “Asking the Right Question: What Does Research Tell Us about Technology and Higher Learning?” that originally appeared in

Change, the Magazine of Higher Learning (1995), 27(2), 20–27

(This paper contains some web links which are not active in the PDF version.)

Asking the Right Question

What Does Research Tell Us About Technology and Higher Learning?

Stephen C. Ehrmann, Ph.D.

Director of Flashlight

American Association of Higher Education

"I've got two pieces of bad news about the experimental English composition course where students used computer conferencing. The first bad news is that, over the course of the semester, the experimental group showed no progress in their ability to compose an essay. The second piece of bad news is that the control group, taught by traditional methods, showed no progress either."

- Paraphrased from a talk by Roxanne Hiltz reporting on an early use of computer conferencing

I've been involved with innovation in higher education--its funding, its evaluation, and research about it--for twenty years, especially innovations having to do with computing, video and telecommunications. During that time I've often been asked: What do computers teach best? Does video encourage passive learning? And Is it cheaper to teach with telecommunications? I don't have answers to those questions. I don't think they can be answered in any reliable, valid way. It takes just as much effort to answer a useless question as a useful one. The quest for useful information about technology begins with an exacting search for the right questions. This essay discusses some useless questions, a few useful ones (and the findings that have resulted), and one type of question that ought to be asked next about our uses of computing, video and telecommunications for learning.

1. BAD QUESTIONS ABOUT THE HIGHER EDUCATION MACHINE

The first group of useless questions seek universal answers to questions about the comparative teaching effectiveness and costs of technology. These kinds of evaluative questions are phrased like, Do computers do a better job of teaching English composition than traditional methods?

Think about it. That question assumes that education operates something like a machine, and that each college is a slightly different version of the same ideal machine. Questions like these use the phrase "traditional methods" to represent some widely practiced method that presumably has predictable acceptable results. If technology performs better than traditional methods, such questions imply, everyone should use it. A neat picture, but traditional methods doesn't define the higher education that I know and love, nor is it the higher education that research reveals.

Postsecondary learning is not usually so well-structured, uniform or stable that one can compare an innovation against traditional processes without specifying in explicit detail just what those processes are. And by specifying in detail what traditional means (what materials, what methods, what motives), you limit your study to a very small and temporary universe. Organizationally our institutions don't behave like machines, either. Cohen and March did a classic study of presidential decisionmaking some years back, coining the term organized anarchy to describe

how our institutions function. The term describes any institution, they said, which, like the typical college or university, has:

1. problematic goals (it appears to operate on a variety of inconsistent and ill-defined preferences),
2. unclear technology (i.e., methods) (Although the organization manages to survive and (where relevant) produce, it does not understand its own processes.), and
3. fluid participation in decision making (the boundaries of the organization appear to be uncertain and changing).

Sound like a machine being fine tuned toward a Platonic ideal of efficiency? To me it sounds not only like what colleges are (and ought to be) but also like what college courses are (and ought to be). Unfortunately this means one can't ask, "How well is this technology-based approach working, relative to the norm?" since there usually isn't a norm.

It also seems useless to search for global generalizations about the costs of technology relative to traditional methods. Howard Bowen, a noted economist of higher education, found that institutions of higher education each raise all the money they can, spend all they get, and spend it in ways that relate closely to the way they spent the money last year. His 1980 study found little relationship in patterns of spending even among institutions that appeared on the surface quite similar. They spent rather different amounts per student, and they spent each dollar differently. Bowen found no way to state rationally what it ought to cost to educate a student properly. Tougher economic times may have forced some convergence in costs among institutions. But we still have no rational way of describing what traditional education should cost per student.

Platonic ideals aside, it's also difficult to determine what education does cost. Prices and accounting methods vary by institution and situation. Services that are inexpensive to some institutions are quite expensive for others. Complicating the cost question still further is the rapid and not always predictable change in technology prices and performance.

None of this suggests that we should ignore issues of cost in looking at new investments in technology. But caution flags should go up whenever you hear someone say the nation can teach English composition more cheaply if it uses technology X, be that technology old or new.

2. IF YOU'RE HEADED IN THE WRONG DIRECTION, TECHNOLOGY WON'T HELP YOU GET TO THE RIGHT PLACE

Questions are also be useless if we fail to ask them. Many advocates of technology want to improve current teaching. But too often they fail to ask whether traditional education has been teaching the right content. They seek to change the means of education but don't ask hard questions first about its objectives. What makes me uneasy about the content goals of undergraduate education is grades, and what research tells us about them.

Any undergraduate can tell you that grades are the key to interpreting the mysteries of higher education. Faculty give you high grades when you learn what they value, right? We tell students

repeatedly: study hard, get good grades and you will learn what you need in order to do better in life.

But is that true? Let's assume that the curriculum teaches knowledge, skills and wisdom that is of advantage to graduates. We'll also assume that faculty members are grading rationally. And although higher education has many goals, not all of them professional or vocational, at least some of them are meant to foster later success in the workplace (e.g., salaries, chances of winning a Nobel Prize, etc.) In that case, research ought to reveal a positive correlation between cumulative grade point average and work outcomes. In other words, your A graduates should have learned enough to do better in their work life than your C graduates. (I'll use graduate to denote anyone who has completed a course of study, whether or not the person receives a degree.) In contrast, if the curriculum were irrelevant to work outcomes (or if grading were random), then the correlation would be zero. It wouldn't matter how efficiently we taught the wrong stuff, or whether we used technology to teach it three times as well. The correlation between GPA and life outcomes would still be zero.

In 1991 Pascarella and Terenzini synthesized all the research they could find bearing on higher learning. Going to college and graduating pays off in many ways, they found. Choice of major makes a difference in life outcomes. All that is good news. But while Pascarella and Terenzini discovered many studies finding a tiny positive correlation between grades and work achievement after graduation, the correlation is so small (about 1-2% of the total variation) as to be meaningless for the individual student.

Why do grades not predict how well our graduates perform? Is it because we are not even trying to teach them certain knowledge, skills and wisdom that they need? Or does the problem lie in the way that faculty assess learning? Are Students Being Taught the Right Stuff?

One possibility is that the curriculum is failing to focus on the knowledge, skills and wisdom that graduates need. For example, some studies of GPA and work outcomes focus just on MBA graduates and their success in their first jobs (e.g., starting salaries, likelihood of promotion, etc.). Findings about MBA graduates by Crooks and by Livingston are consistent with Pascarella and Terenzini's: little relationship between GPAs for business school grads and their work achievement. Perhaps the reason for the tiny relationship is that there are important skills that the curriculum fails to teach or reward. That's the implicit message of *The Competent Manager* by Richard Boyatzis, a classic work published in 1982. The volume summarizes many empirical studies of the cognitive skills of effective managers. Each study compared the patterns of thinking of superlative managers to those of average managers.

Boyatzis found that the cognitive skills of highly successful managers didn't seem to bear much relationship to what business schools were teaching. For example, one of the key skills is the ability to shape and achieve goals by working through coalitions of peers. The habits of thought and action needed to be a good coalition builder need to be developed over many courses and extracurricular activities. Do today's business schools do that, so much so that their highest GPAs are usually earned by students who are best at organizing teams?

Boyatzis' findings have broader significance. Skills of working with people and in organizations are important for just about every graduate, not just business school types. Most forms of work, citizenship and even family life require such skills, knowledge and wisdom.

If you study your own graduates and find that there is no apparent difference in the fate of those who got A's and those who got C's. Perhaps it is because your program is not teaching the right stuff.

Or Is Grading the Problem?

A second way to account for Pascarella and Terenzini's finding is to infer that grading is irrational. Let's assume that most faculty members have no idea what their students think or have learned. By this argument, the students who learn the most may be as likely to get a C as an A. One of the most devastating studies in support of that notion is embodied in a video. **A Private Universe** opens in Harvard Yard during Commencement in the late 1980s. Twenty-two graduating seniors, faculty and alumni were asked one of two questions, "Why is it warmer in the summer than in the winter?" or "Why does the moon seem to have a different shape each night?" Only two of them answered their question correctly. Yet they should have learned about both these phenomena repeatedly while still in school.

The scene then shifts to a good high school nearby. We see ninth graders answering those same two questions incorrectly in the same ways the Harvard seniors did. The ninth graders are interviewed before they're taught the material that year, and then again right afterward. The instruction looks good. But the teacher does not seem to be learning anything about what students believe about these phenomena, despite the fact that she repeatedly asks them canned questions and gets canned answers back. The videotaped interviews show that the students' preexisting theories remained invisible to the teacher, and often untouched by instruction.

A Private Universe is not the only study that shows that students can get A's without truly understanding the material or being able to apply it. When faculty don't understand what students believe, know and can do, they are unlikely to teach or to grade appropriately.

So we have two pieces of bad news. We're probably failing to teach the right stuff but even if we were trying to teach the right stuff, many instructors wouldn't notice whether their students were learning it or not.

I'm not suggesting that we rush out and faddishly transform our curricula. But I do believe that most institutions of higher education are facing a Triple Challenge of outcomes, accessibility, and costs. If not now then in the next few years they will find it increasingly difficult to offer a modern, effective academic program that reaches and retains the students they should be serving for a price that those students and their benefactors can afford. For many institutions, these three issues of outcomes, accessibility, and costs pose real threats to their reputation and well-being. I see no evidence that most institutions will be able to meet this Triple Challenge without substantial use of computers, video and telecommunication. (In fact this Triple Challenge is one reason why technology has been rising to the top of budgets and presidential agendas for the last few years. One can no longer afford to ignore technology and still maintain institutional health.)

However, if we rush out and buy new technologies without first asking hard questions about appropriate educational goals, the results are likely to be disappointing and wasteful.

3. THE MEDIUM ISN'T THE MESSAGE

Several decades ago, as educators began to think seriously about using the new technology of the day for teaching, you'd hear things like television will ruin learning and computers will revolutionize instruction. (Twenty-five hundred years earlier in Greece you'd have heard the same debate about the written word and its impact on dialogue-based education.) In other words they were asking whether a technology could teach without specifying anything about the teaching methods involved.

Richard Clark responded to that type of assertion by arguing, in effect, that the medium is not the message. Communications media and other technologies are so flexible that they do not dictate methods of teaching and learning. All the benefits attributed by previous research to "computers" or "video," Clark asserted, could be explained by the teaching methods they supported. Research, Clark said, should focus on specific teaching-learning methods, not on questions of media. Clark's studies provoked a blaze of responses because he seemed to be saying that technology was irrelevant. A good set of these attacks, with rejoinders by Clark, can be found in two recent issues of Educational Technology Research and Development, cited in the reading list at the close of this essay. Robert Kozma argues, for example, that any particular technology is not irrelevant. Any particular technology may be well or poorly suited to support a specific teaching-learning method. There may indeed be a choice of technologies for carrying out a particular teaching task, he argues, but it isn't necessarily a large choice. There are several tools that can be used to turn a screw, but most tools can't do it, and some that can are better for the job than others. Kozma suggests that we do research on which technologies are best for supporting the best methods of teaching and learning.

I agree with both of them. Clark's message is the more important, however. Too many observers assume that if they know what the hardware is (computers, seminar rooms), they know whether student learning will occur. They assume that if faculty get this hardware, they easily, automatically, and quickly change their teaching tactics and course materials to take advantage of it. Thus technology budgets usually include almost no money for helping faculty and staff upgrade the instructional programs.

As for useful research, we have both the Clark and the Kozma agendas before us:

1. to study which teaching learning strategies are best (especially those that would not even be feasible without the newer technologies) and
2. to study which technologies are best for supporting those strategies.

4. COMPUTER BASED TUTORIALS ARE VALUABLE BUT

At this point it may seem like all the research and evaluation are useless. It's time to turn to some questions that have yielded important information. Since the 1960s the popular image of the computer revolution has rested on individualized computer-assisted instruction. This type of

software teaches by offering some text or multimedia instruction, asking the student questions, and providing feedback and new instructional material based on the student's answers. Each student moves through the materials in a different way, and at a different rate. James Kulik and his colleagues at the University of Michigan have summarized the vast research about such software. They reanalyzed data from large numbers of small studies in order to draw more general conclusions. Their basic finding: this method results in a substantial improvement in learning outcomes and speed, perhaps around 20% or more on average. Such instruction works best, of course, in content areas where the computer can tell the difference between a student's right answer and wrong answer, e.g., in mathematics or grammar exercises. Few other teaching methods have demonstrated such consistently strong results as this type of self-paced instruction.

The news is not all good, however.

Studies such as those analyzed by Kulik and his colleagues have focused purely on the educational value of software, not on factors influencing its viability. Unfortunately, even the best computer assisted instruction of this type has often not found a substantial number of users in higher education. Software intended for educational use often fades away, its revolutionary promise unfulfilled.

A group of us led by Paul Morris created a casebook that analyzed twenty pieces of software developed in the 1980s and early 1990s. These software packages had already demonstrated not only value (educational power, as evidenced by evaluations and awards) but also viability (extensive use over many years). If software is not widely used by many faculty over many years, it is unlikely to foster lasting, national improvement in the way one or more courses are taught. We wanted to understand why a few software packages had proven viable, while so many others were not.

Perhaps our most important finding was that it usually takes years for curricular software to be developed and then to become widely accepted. There are many reasons for this. Support services are often under-funded, so faculty couldn't be certain that the basic hardware and software would be consistently available and in working order. Changing a course involves shifts to unfamiliar materials, creation of new types of assignments, and inventing new ways to assess student learning. It's almost impossible for an isolated faculty member to find the time and resources to do all these things, and to take all these risks. Few institutions provide the resources and rewards for faculty to take such risks. For these and other reasons, the pace of curricular change is slow.

The more revolutionary the software, the longer and more arduous was the task of getting a critical mass of users. For large pieces of curricular software, the journey from conception to wide use might take ten years or more.

Unfortunately, long before most curricular software found such wide use, computer operating systems and interfaces had changed. Instead of looking revolutionary, the software began looking obsolete. Use, instead of growing, began to decline. The lack of obvious returns discouraged funders and publishers from investing in the creation of version 2.0. The original developers had often lost interest, too. Faculty knew that making uninteresting upgrades would

win them few rewards. Thus many valuable curricular software packages died without ever fulfilling their promise.

We did find a few small families of curricular software that found a niche. However many of these packages gained use because they were inexpensive to develop (and thus inexpensive to update regularly) and familiar. They got into use by comfortable, not by making instructional waves. Hardly the stuff of revolution.

That doesn't mean that software isn't used for learning. Ironically, while software designed for learning has had a hard time finding a postsecondary market, most software used for learning was not designed for that purpose.

5. SOFTWARE THAT ISN'T DESIGNED FOR INSTRUCTION CAN BE GOOD FOR LEARNING

Worldware is the name we gave such software. Worldware is developed for purposes other than instruction but is also used for teaching and learning. Word processors are worldware. So are computer-aided design packages. So are electronic mail and the Internet.

Worldware packages are educationally valuable because they enable several important facets of instructional improvement. For example online libraries and molecular modeling software can support experiential learning. Electronic mail, conferencing systems and voice mail can support collaborative learning by non-residential students.

Worldware packages are viable for many reasons. They are in instructional demand because students know they need to learn to use them and to think with them. Faculty already are familiar with them from their own work. Vendors have a large enough market to earn the money for continual upgrades and relatively good product support. New versions of worldware are usually compatible with old files. Thus faculty can gradually update and transform their courses, year after year, without last year's assignment becoming obsolete.

For reasons like these, worldware has often proven to have great educational potential (value) and wide use for a long period of time (viability). Has that educational potential been realized in improved learning outcomes? There is no substitute for each faculty member asking that question about his or her own students. Here are two such studies.

Karen Smith pioneered what is now an increasingly common application of electronic mail--as an important element in teaching foreign languages. Students of Spanish at the University of Arizona were told to write to one another using a form of electronic mail called computer conferencing. The faculty suggested some topics, e.g., the film the class had just seen, reviews for upcoming quizzes. Other topics came from the learners, e.g., an upcoming party and one student's existential angst. Some of these e-mail conversations were private. Conversation in the public conferences was graded but only for fluency of expression, not for content or grammar.

I met the first cohort of students taking this course. I've never seen a group, before or since, so excited about their course's use of technology. In part they were pleased because computer

conferencing was more accessible than a language lab; they could participate from any computer at any time. More important, as several put it, I'm using Spanish for the first time. And they didn't need to feel self-conscious about speaking quickly or with a good accent. All they needed to do was take the time to interpret what had been said (i.e., written) to them and then decide how to express their replies.

Surprisingly, Smith's study showed that, relative to a class taught using a traditional language laboratory, the oral performance of these students excelled. In the slower paced, more anonymous world of the computer conference, they were speaking Spanish with a purpose, and learning to express themselves. The evaluation proved that worldware had been used in a way that opened a new dimension of learning for these students.

Another of my favorite evaluations of teaching tactics was never published. The faculty member was simply interested in seeing whether his use of technology was improving his student's learning. Bob Gross, a professor of Biology at Dartmouth College, was an early user of personal computers to create animations. In the late 1980s, he became impatient about a bottleneck in his teaching. It was taking him two class hours to teach about a complex series of interactions in biochemistry--48 blackboards worth as he put it. He would draw the molecules, talk, erase some, draw some, and talk some more. Gross wanted to speed up the process and make it more effective. In several weeks of work with an undergraduate student, he used worldware to create an animation that enabled him to teach the same material in half an hour. The students could also study the computer-based animation outside class, frame by frame if need be. I was initially disappointed, he told me the day I visited him at Dartmouth, some months afterward. There was very little excitement or discussion when I showed it in class. But later, when I gave them my regular exam on the subject, they did better than any previous class. These two studies show that each faculty member can do his or her own research, asking the kinds of questions about what students are learning. That's what Schneps and others have shown is so important: know thy own students and what they are learning. Without asking hard questions about learning, technology remains an unguided missile.

6. STRATEGIES MATTER MOST

Studies by individual faculty of their own students and their own teaching methods and resources are necessary. But such studies are not enough. I suggest the following hypothesis:

Education can affect the lives of its graduates when they have mastered large, coherent bodies of knowledge, skill and wisdom. Such coherent patterns of learning usually must accumulate over a series of courses and extracurricular experience. Thus, to make visible improvements in learning outcomes using technology, use that technology to enable large scale changes in the methods and resources of learning. That usually requires hardware and software that faculty and students use repeatedly, with increasing sophistication and power. Single pieces of software, used for only a few hours, are unlikely to have much affect on graduates' lives or the cost-effectiveness of education (unless that single piece of software is somehow used to foster a much larger pattern of improved teaching).

Thus far few educators, evaluators and researchers have paid much attention to educational strategies for using technologies. Too often they've been victims of "rapture of the technologies." Mesmerized, they focus on individual pieces of software and hardware, individual assignments and, occasionally, to individual courses. [Enrolling more adult learners has been a more powerful motive to change strategies, and to study those strategies. For a fine strategic evaluation of seven institutional projects to transform whole degree programs, I suggest Markwood and Johnstone's study, *New Pathways to a Degree: Technology Opens the College*.]

Few educators are thinking much about educational strategies for using technology to improve learning outcomes. Does that mean we're not employing such strategies yet? Quite the contrary. Here's an example.

Back in 1987 Raymond J. Lewis and I were looking for faculty members who had at least two years of teaching in an environment where students had unfettered access to personal computing.

One place we visited was Reed College in Portland, Oregon, where the current seniors had four years of easy access to Macintosh computers. I talked to faculty members from eight departments, asking what they liked about teaching in this environment.

Surprisingly, there was one thing that all of them had noticed. As two of them put it, I'm no longer embarrassed to ask the student to do it over again. Because computer-based documents and projects are mechanically easier to revise, their students pressed to get a second chance to improve their work and their grade. Gradually the texture of the curriculum in each course was changing: toward projects developed in stages--plan, draft, conversation, another draft, final version. Each stage of work was marked by rethinking, and by learning. We called this strategy *Doing It Again, Thoughtfully (DIATing)*.

I also talked asked a couple of seniors if they thought their education had been influenced by their use of computers. One of them replied that he'd learned that it's not one's first draft or thought that matters, but the final version. In what course had he learned that, I asked. He replied that it had been over a series of courses. Similarly, several faculty members and the director of the writing program independently suggested that the most tangible impact of computer availability would be at the capstone of the curriculum, in the intellectual tightness and coherence of bachelor's theses.

The day at Reed had a surprise ending. When Ray and I sat down with several of the College's educational and technology leaders, they were astonished by what we'd heard that day. The growth of *DIATing* had been an ecological change, not directed centrally. They hadn't known that their technology was being used in that way or with those kinds of outcomes. That's because their institutional strategy was the sum of large numbers of independent actions by many faculty members and students across the college.

From this story (and my other experiences with educational uses of information technology). I'd suggest three lessons:

1) Technology can enable important changes in curriculum, even when it has no curricular content itself. Worldware can be used, for example, to provoke active learning through work on complex projects, rethinking of assumptions, and discussion.

2) What matters most are educational strategies for using technology, strategies that can influence the student's total course of study.

3) If such strategies emerge from independent choices made by faculty members and students, the cumulative effect can be significant and yet still remain invisible. (Unfortunately, the converse can also be true. We may be convinced that we have implemented a new strategy of teaching across the curriculum, and yet be kidding ourselves.) As usual, there is no substitute for opening our eyes and looking.

7. TOOLS FOR EVALUATING STRATEGY: THE FLASHLIGHT PROJECT

Ordinarily what matters most is:

- not the technology per se but how it is used,
- not so much what happens in the moments when the student is using the technology, but more how those uses promote larger improvements in the fabric of the student's education, and
- not so much what we can discover about the average truth for education at all institutions but more what we can learn about our own degree programs and our own students.

How can departments and institutions study their educational strategies for using technologies? A faculty can't do this alone by looking at just one course. As we saw in the DIATing example from Reed, a strategy is a pattern of teaching and learning that extends over many courses. Only a college, university or department has the range of responsibility and resources to study strategy.

The Annenberg/CPB Project is taking some steps to make it easier for educators to obey the commandment--know thy students and what they are learning. January 1995 saw the birth of the Flashlight Project. It's a three year effort to develop and share evaluation procedures. Colleges and universities will be able to use these procedures to assess their educational strategies for using technology. We're working with the Western Interstate Commission on Higher Education (WICHE), Indiana University Purdue University at Indianapolis (IUPUI). IUPUI, the University of Maine at Augusta, the Maricopa Community Colleges, the Rochester Institute of Technology, and Washington State University will test the new procedures.

In a previous planning phase, supported by the Fund for the Improvement of Postsecondary Education (FIPSE), our group identified the educational strategies that their institutions most needed to study. Developing good evaluation procedures is expensive. We wanted our procedures to be widely used and important, so we focused them on educational strategies for using technology that are widely used and important.

The chosen educational strategies include: - project-based learning in an information-rich, tool-rich environment; - collaborative learning when communication can be synchronous and asynchronous; - learning at paces and times of student's choosing; - learning marked by continuous improvement of a piece of work; and - improved student-faculty and student-student interaction, and enhanced feedback.

Now Flashlight is developing procedures that institutions can use to monitor the evolution, successes and failures of those strategies locally. Flashlight outcomes measures will focus on graduates' capabilities, changing patterns of enrollment and retention, and the influence of changes in education on total patterns of costs.

As its name indicates, Flashlight's evaluative procedures will not answer all questions that an institution might have. Nor will it be easy or inexpensive to ask these evaluative questions. We do hope that the answers will prove unusually useful for transforming teaching and setting policy.

If you would like to follow the development of the Flashlight Project over the next several years, there is a new listserv on which we discuss project progress and strategy. We invite questions about evaluation and suggestions about where Flashlight should go. The way to subscribe is to address an Internet message to LISTSERV@WSUVM1.CSC.WSU.EDU with the one line message:

SUBSCRIBE F-LIGHT your firstname your lastname

Another way to engage in a more general discussion with almost 2000 other educators interested in issues of technology, teaching and learning is to sign on to the American Association of Higher Education's listserv on technology, AAHESGIT. To subscribe, address an Internet message to LISTPROC@LIST.CREN.NET with the one line message:

SUBSCRIBE AAHESGIT your firstname your lastname

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