

LITRE

Learning in a Technology-Rich Environment

A quality enhancement plan
for North Carolina State University

Developed in preparation
for reaffirmation of accreditation
by the Commission on Colleges
of the Southern Association
of Colleges and Schools

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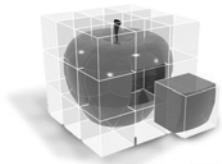
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Executive Summary

LITRE is an empirical research program aimed at enhancing the extensive learning with technology opportunities available to students and faculty at North Carolina State University. Although LITRE is the quality enhancement plan portion of NC State's reaccreditation portfolio for the Southern Association of Colleges and Schools, it is primarily a university-wide initiative that has been embraced by our faculty, students, and administration as essential to the learning, research, and outreach missions of our institution.

The LITRE plan is the result of eighteen months of initial investigation into opportunities to significantly upgrade the already impressive technology-enhanced learning environment at NC State. This preliminary investigation was conducted by research groups made up of NC State's faculty, staff, and students. The groups focused on five areas: 1) educational infrastructure, 2) student information fluency, 3) faculty engagement, 4) learning resources and educational technology applications, and 5) e-learning environments. The recommendations of these research groups were presented to the faculty at a campus forum held in spring 2003. Later that spring the investigations of the research groups were expanded with an extensive campuswide survey (55 percent response rate) that elicited faculty views on the current condition and possible enhancement of technology-aided learning.

The combined research, forum, and survey results helped the LITRE team identify a list of promising opportunities for institutional investment in technology-enhanced learning. During summer 2003, groups of faculty and staff developed this list into twenty-two proposed implementation plans. A panel of the LITRE team agreed that all of these proposals were strongly linked to NC State's success in improving its learning environment, but also winnowed the list to twelve plans, based on likely funding limits and potential for immediate measurable impact on the learning environment. This reduced list was presented to the university community at the Educational Technology Expo in the fall of 2003 and was subsequently forwarded to NC State's SACS leadership team.

After substantial analysis and discussion, the SACS leadership team identified a set of five initial actions for immediate implementation. These actions are the starting point of the ongoing LITRE initiative. The clear understanding of the LITRE team is that each of the issues identified in the original set of proposals must be addressed if NC State is to optimize our technology-enhanced learning environment. However, appropriate research protocol and severe university budget constraints limit the extent of the immediate efforts. The initial items are: 1) expanding and expediting the classroom technology improvement plan, 2) implementing and testing the new university standard for classroom technology in a limited number of classrooms, 3) deploying a new classroom-based technology learning system, 4) establishing pilot technology-enhanced workspaces for student group projects, 5) initiating a faculty-support grants program. In addition, the leadership team acted to establish a sustainable LITRE organization, led by a principal investigator recruited from the faculty.

The LITRE plan describes the process by which NC State will leverage scholarly investigation and judicious additional investments to further capitalize on its \$30 million program of educational technology. LITRE's ultimate goal is to produce students with superior abilities to harness technology to reason, investigate, and communicate.

Document description

The LITRE quality enhancement plan describes and analyzes the current learning environment at North Carolina State University and reports on the initial investigations of LITRE's research groups. These results identify critical gaps that the university must address to build and enhance its technology-rich learning environment and student learning. The QEP launches several immediate initiatives that target critical needs in facilities improvement and support for faculty innovation.

To guide ongoing LITRE efforts, the QEP establishes an ongoing empirical inquiry into which aspects of a technology-rich environment are most effective in improving student learning. NC State will use the empirical evidence LITRE collects to inform future LITRE projects, programs, services, and policies.

Finally, the QEP describes the LITRE organization, an investigative unit that will guide implementation of the plan, reflect on the results of LITRE research, and disseminate results.



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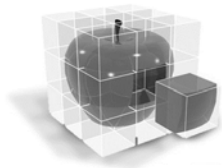
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List of Acronyms

CALS	College of Agriculture and Life Sciences
CED	College of Education
CHASS	College of Humanities and Social Sciences
CNR	College of Natural Resources
CoE	College of Engineering
CoM	College of Management
CoT	College of Textiles
CVM	College of Veterinary Medicine
CUE	Council on Undergraduate Education
DE	distance education
DESIGN	College of Design
DELTA	Distance Education and Learning Technology Applications
EdTech	Exposition of Educational and Instructional Technologies
ERIC	Educational Resources Information Center
ETF	Educational and Technology Fee
FCTL	Faculty Center for Teaching and Learning
FP&D	Facilities, Planning, and Design
GERs	general education requirements
GIS	geographic information systems
HEFC	North Carolina State Commission on Higher Education Facilities
HPC	high performance computing
html	hypertext markup language
IDEA	Innovation in Distributed Education Applications (grants program)
IMAP	Internet message access protocol
IMPEC	integrated math, physics, engineering, and chemistry curriculum
IT	information technology
ITD	Information Technology Division
LITRE	Learning in a Technology-Rich Environment
LMS	learning management systems
LOBO	Library Online Basic Orientation
LRCDA	Learning and Research Center for the Digital Age
LTS	Learning Technology Service
MMUG	Multimedia Users Group
NCIH	North Carolina Information Highway

NCNI	North Carolina Networking Initiative
NC-REN	North Carolina Research and Education Network
NLII	National Learning Infrastructure Initiative
PAMS	College of Physical and Mathematical Sciences
PDA	personal digital assistant
QEP	quality enhancement plan
RPT	reappointment, promotion, and tenure
SACS	Southern Association of Colleges and Schools
SCALE-UP	Student-Centered Activities for Large Enrollment Undergraduate Programs
SOTL	scholarship of teaching and learning
TLT	teaching and learning with technology
TLTR	Teaching and Learning with Technology Roundtable
TRLN	Triangle Research Libraries Network
UPA	University Planning and Analysis
WRAP	Web realm authentication protocol



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Introduction

The faculty are the enduring heart of North Carolina State University, and they seek to provide a rich educational experience for their students. NC State is known for its strength in science and technology, and its faculty have been leaders in exploring the potential of technology to enhance learning outcomes. Much of NC State's current instructional technology infrastructure has its foundation in grassroots faculty initiatives.

Like many structures with grassroots underpinnings, however, the instructional technology infrastructure at NC State is uneven. Excellent examples of facilities, programs, and services are offset by critical gaps. NC State's choice of "Learning in a Technology-Rich Environment" as the theme of its quality enhancement plan seeks to buttress our already impressive learning environment by focusing our educational technology efforts on the goal of improving student learning. (For a definition of student learning, see appendix A.) The key players in this effort will be the faculty, who are the best judges of when to select instructional technology as an appropriate pedagogical tool.

Faculty and students look to the university to provide an environment that effectively facilitates teaching and learning. LITRE is a means of helping the university meet that responsibility. The immediate goals of the LITRE plan are:

- to bring a faculty-based, reflective perspective to the university's strategic planning and policy making related to technology and student learning;
- to coordinate projects sharing the common objective of improving learning with technology;
- to facilitate communication, partnerships, and resource leveraging among various faculty, departments, colleges, and divisions so that improvements spread throughout the university;
- to accelerate instructional technology innovation throughout the university by addressing gaps in our technology environment, and testing and implementing promising technology initiatives.

Foundation of LITRE: The NC State mission

NC State's choice of "learning in a technology-rich environment" as the theme of its quality enhancement plan tailors the Southern Association of Colleges and Schools' required focus on student learning to NC State's unique campus climate and mission. As a doctoral/research-extensive land-grant institution, NC State has a three-part mission: teaching, research, and extension and engagement. As a comprehensive university, NC State has a diverse faculty, diverse programs, and a diverse student body. As a flagship institution in the University of North Carolina, NC State has a rich tradition and many historic strengths, particularly in science and technology.

The NC State mission statement addresses the creation of an innovative learning environment directly, indicating how it is to be achieved and spelling out desirable learning outcomes: "Through the active integration of teaching, research, extension, and engagement, North Carolina State University creates an innovative learning environment that stresses mastery of fundamentals, intellectual discipline, creativity, problem solving, and responsibility."

We at NC State believe that we can best enhance our technology-rich learning environment by actively integrating teaching, research, and extension and engagement. Further, we believe that the enhancement of our learning environment must respect our institutional mission, our innate diversity, and our historic strengths. Accordingly, we propose a quality enhancement plan that taps into our faculty's strength as disciplinary specialists and researchers to ensure that every technological innovation and institutional change is effective in improving learning outcomes, both general and discipline-specific, and both for our traditional population and for learners outside the university's walls.

The evolution of the LITRE vision

NC State's belief in the power of technology to enhance the learning environment surfaced in the university's strategic plan in 1995, when an explicit goal was "to use technologies to improve teaching and learning, to disseminate knowledge, and to improve access to university resources." An implementation plan unveiled in 1996 established a learning technology center (now the Learning Technology Service), a plan to support media production across campus (now supplied by LTS, the Libraries, and some colleges), and a campuswide symposium to highlight and share faculty and student experiences using educational technology (now the annual Exposition of Educational and Instructional Technologies).

By 2000, teaching and learning with technology had become a high priority across the university. The compact plans of the provost and nearly every college included one or more initiatives focused on using technology to improve teaching and learning. Among these initiatives was the creation of a vice provost for Distance Education and Learning Technology Applications (DELTA).

During this period, surveys of students indicated satisfaction with access to technology at NC State and with the level of computing skills they had developed here. Surveys of alumni indicated that they, too, were satisfied with the technology skills they had developed. However, these surveys also identified a weakness in student training and support for using technology. These results suggested that NC State had both strengths to build on and opportunities for improvement, and administrators responsible for technology in teaching and learning began to respond.

The university administration determined that teaching and learning with technology had become a strategically important issue requiring focused, university-wide planning. In 2001, after North Carolina voters had approved a \$468 million renovation and construction program in a 2000 referendum, the Facilities Division began to develop new standards for technology in classrooms. In 2002, anticipating the choice of LITRE as a theme for our quality enhancement plan, the university asked all academic and administrative units to include LITRE-related initiatives in their compact plans.

Early in 2002, learning in a technology-rich environment was identified as a possible focus for the Southern Association of Colleges and Schools quality enhancement plan during discussions in the Deans Council, the Provost's Office, executive officers' meetings, and the University Council (which includes the deans, vice chancellors, and faculty and student leaders). Although other topics were considered, LITRE was the single topic recommended by the Deans Council, and in summer 2002 the executive officers and chancellor endorsed that recommendation. LITRE was born.

To guide its inquiries, the LITRE team established the following vision statement:

Learning in a Technology-Rich Environment Vision Statement

In the twenty-first century, North Carolina State University will use its historic strength in technology to pursue its stated mission "to create an innovative learning environment that stresses mastery of fundamentals, intellectual discipline, creativity, problem solving, and responsibility."

- By facilitating communication, course management, and presentation, a technology-rich environment can enhance laboratory and classroom teaching and learning.
- By diversifying and enhancing teaching and learning tools, a technology-rich environment can help faculty accommodate students' individual learning styles and circumstances.
- By enriching library, research, and database infrastructures, a technology-rich environment can encourage active, inquiry-driven learning.
- By improving access to learning resources and providing new educational venues, a technology-rich environment can extend the expertise of the university beyond the university walls.
- By expediting university services, a technology-rich environment can conserve scarce resources.

Technology has limitations. It is a tool for achieving the university's mission, not an end in itself. It is an effective tool only when it is in the hands of skilled users, and only when its application is appropriate, reliable, integrated, supported, and sustainable.

Building on NC State's strengths

NC State spends more than \$30 million annually on educational technology, and the learning environment that we have created with this investment is impressive and robust. Students and faculty count on the award-winning digital resources of the NCSU Libraries, our state-of-the-art network backbone, and high-speed access to the resources of the Internet, the N.C. Research and Education Network, and Internet2. The university provides reliable e-mail services and file storage space to all students and faculty, access to sophisticated commodity and discipline-specific software, Web-publishing privileges and support, and efficient help-desk services. To advance discipline-specific programs, colleges deploy leading-edge technology resources.

Furthermore, NC State's faculty and students are deeply involved in teaching and learning with technology. Our general education requirements mandate that students demonstrate technology skills, and the quality of every program rests in part on our effectiveness in teaching those skills. Off-campus distance education is the fastest growing segment of our enrollment, and the students in those programs require access to robust technology options. New students arrive on campus with greater and greater skills and expectations for technological sophistication, and the degree to which technology can enhance their learning continues to expand.

The LITRE project will build on these institutional strengths. Research generated by the project will provide useful strategies for ensuring that our considerable investments in instructional technology effectively and efficiently improve student learning.

Campus involvement in LITRE

The development of the LITRE plan benefited from broad, campuswide representation. The membership of the LITRE team included a faculty member from each college, a representative of the Faculty Senate, and a representative from each administrative unit with relevant responsibilities, such as Student Affairs, DELTA, the Libraries, the Faculty Center for Teaching and Learning, and the Information Technology Division. LITRE was co-chaired by Professor Hugh Devine, a campus leader in the use of technology in teaching and learning, and Sharon Pitt, director of the Learning Technology Service in DELTA.

LITRE's leadership met with key groups across campus, including the Board of Trustees, the executive officers, the Deans Council, the Graduate School Advisory Board, the Teaching and Learning with Technology Roundtable, the Undergraduate Academic Operations Council, the Graduate Administrative Board, college cabinet meetings, and the Faculty Senate. In addition, LITRE maintained a Website for campus communication, and the university Website and *Bulletin* published articles periodically throughout the planning effort. Members of the LITRE team were regular participants in NC State's Teaching and Learning with Technology Roundtable,

To address the work of LITRE, the LITRE team established a steering committee and five focused research groups: Educational Infrastructure, Student Information Fluency, Faculty Engagement, Learning Resources and Educational Technology Applications, and E-Learning Environments. Chaired by selected members of the LITRE team, these research groups included not only LITRE team members but also interested faculty, staff, and students across campus. In all, approximately seventy people were involved in the preliminary research efforts.

To ensure that the quality enhancement plan would be in accord with best practices in the broad field of teaching and learning with technology, the LITRE team gave due consideration to the scholarly literature and to related practices of our institutional peers. Preliminary bibliographic underpinnings for the study were compiled for the LITRE team with the cooperation of the Faculty Center for Teaching and Learning, the Libraries, and University Planning and Analysis. (For a bibliographic essay and select annotated bibliography, see appendix B.) In late February, several members of the team attended and presented at the UNC Teaching and Learning with Technology Collaborative conference in Greensboro, North Carolina. In early March 2003, five members of the LITRE team traveled to George Mason University to tour their state-of-the-art facilities.

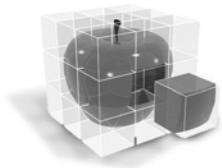
In April 2003 the LITRE team hosted a well-attended Campus Forum to solicit ideas and preliminary reactions to the LITRE goals and possible projects. The chancellor and provost made introductory remarks, and the

chairs of the research groups presented preliminary findings. Forum participants included deans, faculty, staff, and students.

To elicit ideas from students, LITRE held student focus groups. To amass data on the current state of technology-enhanced instruction at NC State, in spring 2003 the LITRE team developed and administered a faculty survey. The team relied heavily on the results of this survey to prioritize its recommendations and establish its organization and first-wave initiatives.

After establishing its first-wave initiatives, the LITRE co-chairs gave a preliminary presentation of the QEP at NC State's 8th annual Exposition of Educational and Instructional Technologies (EdTech Expo). A late draft of the plan was presented at the December meeting of the Teaching and Learning with Technology Roundtable.

To ensure a high level of involvement and commitment, the LITRE plan was reviewed fully across campus (by faculty, staff, deans, and executive officers) before it was finalized in early 2004.



CHAPTER 1

NC State's Teachers and Learners

As a flagship institution in the University of North Carolina system, NC State has a rich tradition and many historic strengths, particularly in science and technology. Many of our disciplines teach technology as an integral part of their content. Technology is so basic to the subject matter of engineering, statistics, genetics, and design that it is difficult to find the line between the traditional discipline and the technology associated with it.

Furthermore, technology has transformed even disciplines that do not define technology as a content area, freeing learners from mundane chores so that they can turn their attention to larger issues requiring analysis and critical thought. In many disciplines, technology has enriched content far beyond the bounds of print-only environments.

To the extent, however, that technology has become content to be taught and learned, we must recognize that something can be lost. Faculty who spend time learning to use technology may spend less time on more traditional pursuits of the university mission: interacting with students, research in their disciplines, extending the expertise of the university to the public. Faculty who take class time to teach students how to use technology have less time to cover the traditional content of their disciplines.

In some disciplines, faculty judge that the benefits of learning to use relevant technologies and teaching students to use them exceed the cost of doing so. In others, faculty believe that traditional content is more important. The proper judges of the appropriate balance are the faculty.

NC State's history of faculty innovation

NC State's faculty have been innovative leaders in exploring the potential of technology to improve the university's learning environment. Much of our current instructional technology infrastructure has its foundation in grassroots faculty initiatives. Our experiments with technology have provided us with a rich resource base on which we can draw to build and develop our technology-rich learning environment.

Faculty-initiated programs

The Eos/Unity academic computing environment

In 1989 representatives of the NC State College of Engineering Computer Committee traveled to the Massachusetts Institute of Technology to investigate and assess the innovative Athena Project. Begun in 1983, this project was a decade-long effort by MIT, IBM, and Digital Equipment Corporation to develop a large-scale academic network with software specifically designed for educational and research computing.

Impressed by the power, security, scalability, and all-round functionality of Athena for a large user community, the committee set about the task of importing the Athena technology to NC State. They called the system they developed Eos. Since its first year of operation in 1990, students, staff, and faculty have been adapting and extending Eos, taking it well beyond its Athena origins to the large-scale, multi-platform network it is today.

Three other colleges joined Eos in 1992 and 1993, and in 1994, NC State's Computing Services took on the role of setting up and administering the infrastructure for the entire campus, calling the integrated system Unity.

Project 25

As a pilot project, in 1997-98 the faculty adapted, delivered, and evaluated more than twenty-five courses on the World Wide Web (Project 25). The goal of the project was to explore the potential of the Web for course delivery.

The twenty-nine faculty who participated in Project 25 contributed extraordinary amounts of time, energy, and creativity to the project. They were assisted by the professional staff in Computing Services, the Libraries, and the new Learning Technology Service, who offered training, technical, and logistical support, server maintenance, and other assistance.

The Project 25 classes were rigorously assessed. Six Web-based classes were compared directly to classroom-based instruction offered by the same instructors during the same semester. The assessment results showed that the difference between student academic performance in classroom-based and in Web-based learning environments was not statistically significant.

Participating faculty said, however, that preparing and delivering the Web-based courses was much more time consuming than preparing and delivering instruction for the classroom. All of the professors chose to participate in Project 25 at least in part because they were sufficiently comfortable with computers to feel that they could successfully offer a course in that manner. However, not all of the professors were comfortable using hypertext markup language, or even html overlay programs, nor did they feel that this knowledge should be required of them.

In view of the time commitment involved, many faculty recommended an incremental approach to Web-based course offerings, by which professors would develop Web materials to supplement traditional classes over a period of years until they had enough of a library to offer a stand-alone Web-based course.

Engineering Pilot Laptop Program

Although almost 95 percent of NC State students own their own computers, NC State has never defined a standard student-owned platform that would interface seamlessly with NC State's Eos/Unity network and environment.

Learning at NC State increasingly occurs on-line, augmenting activities in the classroom and laboratory. To encourage more effective use of technology in the classroom, improve the learning and teaching environment, and to evaluate the potential of laptop use for engineering students, in 2001 the College of Engineering worked with IBM and Dell in establishing a pilot laptop program. The program combines practical, financial, and educational incentives in a program of shared courses and computing.

Launched in fall 2001 with a group of incoming freshmen in the University Honors Program, the program was expanded to all incoming engineering freshmen in fall 2002. Students who choose to participate must purchase one of the specified laptops.

Faculty design courses to take full advantage of the computers in their instruction. The program is open to all first-year engineering students. Although the program was limited to 200 incoming freshmen for fall 2003, anyone on campus can purchase laptops on the plan.

Mobile computing initiative

To train and equip students with technologies that will enable them to improve animal health care, faculty in the College of Veterinary Medicine have launched a mobile computing initiative. In this program, CVM purchases Palm OS-based PDAs and distributes them to third-year students, who carry the devices throughout their clinical experiences. The devices enable collaboration with colleagues and provide interactive access to critical information, such as a drug formulary, an antibiotic efficacy database, and a Spanish medical dictionary. Specially formatted electronic reference materials are acquired and made available by the Veterinary Medical Library.

The College of Agriculture and Life Sciences has been experimenting with a similar program. The use of technology in such programs helps build a dynamic learning community in which students become the active producers and sharers of knowledge.

WebAssign

Starting as an idea of a graduate student, one of NC State's premier technology projects is a tool for grading student homework called WebAssign. WebAssign grades individual homework sets instantly and accurately, giving students immediate feedback.

Although WebAssign has its origins in science, math, and engineering, it is very adaptable and works well in many other disciplines. It offers faculty a choice of over 300,000 questions, including many taken from end-of-chapter exercises in course textbooks. By freeing faculty from routine grading, WebAssign gives faculty more time to interact with students. Because the program randomizes values in problems, students cannot simply copy a friend's answers to complete an assignment. With WebAssign they have to ask, how did you get that answer and why? This is peer learning at its best.

WebAssign is used by about 15,000 students at NC State, and has spun out of NC State and become a commercial enterprise housed on Centennial Campus. Current usage is 100,000 students taught by 1,200 instructors in 2,400 classes at 350 colleges and high schools around the nation.

WolfWare

WolfWare was developed to respond to a need expressed by faculty in the Colleges of Engineering and Physical and Mathematical Sciences for a Web-based homework submission system. The program was designed and built by staff in the Department of Computer Science, the College of Engineering's Information Technology and Engineering Computer Services, the College of Physical and Mathematical Sciences, and the Information Technology Division. Substantial feedback and assistance from Registration and Records, the College of Agriculture and Life Sciences, the College of Humanities and Social Sciences, and the Learning Technology Service improved its design and usability. The system that developed from this collaboration, WolfWare, is a Web-based course management system that is able to leverage the robust file handling of AFS to scale a common system of locker creation across the university.

WolfWare lockers allow faculty to store course material for students in a common place. This material varies widely, but it usually includes course syllabi, assignments, and material that used to be given to students as photocopied handouts. Recently, WolfWare has added a feature that allows faculty to add streaming media files to their lockers.

WolfWare lockers are kept secure by a password-protected WRAP system (Web realm authentication protocol). Faculty can choose whether to restrict access to the class or make it more widely available. WolfWare also offers some course management features, including class roll management, mailing lists, and homework submission. It provides a message board facility and a comprehensive gradebook, which allows faculty to submit their grades electronically to Registration and Records.

WolfWare was tried initially in nine classes in fall 1999. More than seventy-five courses participated in the spring semester 2000 beta test, including the entire Department of Computer Science. Testing continued through the summer, and in fall 2000 the first production version of WolfWare for general campus use was introduced.

WolfWare is very widely used. In fall 2003, of the 6,454 course sections offered at NC State, 2,051 had activated WolfWare lockers, covering 930 distinct courses.

LOBO

A good example of faculty/librarian collaboration is the Library Online Basic Orientation, an on-line information literacy tutorial. Developed by librarians and first-year writing instructors, LOBO is used in introductory English courses, including those required by the university's general education requirements.

The LOBO tutorial is self-paced, modular, and interactive. Students can use LOBO from any computer. Each module exposes students to a different information literacy concept and guides them through a part of the research process. Students print out LOBO worksheets to give to their instructors for credit.

In 2003 the Libraries received the American Library Association's Information Today Library of the Future Award for LOBO. In October 2003 the Internet Education Project recognized LOBO as Site of the Month. Both awards cited the effective use of information technologies, links to virtual reference services, and the strong collaboration between librarians and first-year writing faculty in developing the tutorial.

SCALE-UP

Student-Centered Activities for Large Enrollment Undergraduate Programs was the creation of Professor Robert Beichner of the Department of Physics. By creating a highly collaborative, hands-on, computer-rich, interactive learning environment, SCALE-UP helps students in large-enrollment classes become active learners.

The SCALE-UP project evolved from the IMPEC (integrated math, physics, engineering, and chemistry) curriculum project run by Richard Felder. SCALE-UP took the interactive pedagogy of the IMPEC project and devised ways to implement it in classes of ninety-nine students. (This matched the average enrollment of the traditional introductory physics classes.) The program also matched the staffing: one faculty member, one graduate student (teaching four lab sections) and sometimes an undergraduate grader.

SCALE-UP started in a lecture hall, moved to a 54-student room, and then moved to a 99-student classroom in Harrelson G108. The faculty have continuously experimented with table design and layout, as well as class management issues. The result is a robust learning environment that has been used by more than 1,000 NC State students and many undergraduates at other schools that have adopted this approach. Faculty provide a series of workshops and talks for institutions wanting to know more about the approach.

Evaluations through focus groups, interviews, portfolios, and standard testing instruments (with a pretest/post-test protocol) have demonstrated SCALE-UP's effectiveness in improving students' problem-solving skills, conceptual understanding and attitudes, and in reducing failure rates, especially for minorities and women. Course materials have been incorporated into the leading introductory physics textbook used by more than a third of all science, math, and engineering majors in the country.

Recognizing and rewarding faculty innovation

NC State offers several programs to recognize and reward faculty innovation in teaching and learning with technology.

DELTA's Innovation in Distributed Education Applications Grants enhance the technology-rich learning environment by promoting innovation in the use of instructional technology in distance teaching and learning. IDEA Grants provide funds and personnel to NC State faculty and staff to support planning, design, and development of on-line distance education courses, programs, and resources. IDEA Grants are awarded in part on how well proposals meet NC State's strategic curricular objectives, in particular the creation of full degree programs offered by distance education. From 2000 (the first year grants were offered) to 2003, 118 recipients have been awarded IDEA Grants totaling over \$1.6 million.

In 2002 NC State established an award program to honor the creative pedagogy of NC State's faculty and their work in integrating new technologies into teaching. The first award recipient was Dr. Michael Rappa, the Alan T. Dickson Distinguished University Professor of Technology Management, who was recognized for his course Managing the Digital Enterprise.

In its second year, the award was endowed with an annual gift and named for Gertrude Cox, NC State's First Lady of Statistics. Sponsored by the Teaching, Learning, and Technology Roundtable, the Faculty Center for Teaching and Learning, and the Learning Technology Service, the Gertrude Cox Award honors the creative pedagogy of NC State's faculty and their work in integrating new technologies into effective teaching strategies.

Nominations for the Gertrude Cox Award in subsequent years were received from a broad range of disciplines and were peer reviewed by a panel of judges. The nominees were honored at a reception and demonstration. Robert Beichner, the 2003 recipient, was recognized for his work on SCALE-UP (Student-Centered Activities for Large Enrollment Undergraduate Programs). H. Larry Brown, the 2004 recipient, was recognized for using technology to facilitate skill acquisition and provide individual feedback in physical education courses.

Sharing the news

NC State's annual Exposition of Educational and Instructional Technologies provides ample evidence that NC State's faculty are already exceptionally innovative in employing technology to improve student learning. In each of the last eight years, the faculty have presented dozens of poster sessions at the EdTech Expo displaying technology-based initiatives that enrich academic program content, facilitate learning interactions, and extend resources to hard-to-reach audiences. At EdTech 2003 about fifty exhibitors shared new ideas and lessons learned.

The well-attended, monthly campus Teaching and Learning with Technology Roundtable encourages faculty to support each others' efforts to produce and disseminate technology-assisted instruction. TLTR is one of 600 roundtables in operation on campuses nationwide based on a model created by the Teaching, Learning and Technology Group, originally part of the American Association of Higher Education. The NC State TLTR has been asked to advise the administration on course management systems, intellectual property, and other issues.

Since fall 2001, the Learning Technology Service has coordinated the meetings of a Multimedia Users Group. MMUG's monthly sessions are aimed at faculty and graduate students attempting to integrate multimedia technologies with on-line teaching. Recent discussions have focused on streaming media technologies and newly emerging approaches for multimedia databases. The meetings often feature real-time demonstrations.

Technology training and support for faculty

The creation of an effective learning environment is always an intentional act. To optimize learning outcomes, instructors must make a number of informed pedagogical decisions designed to promote students' active engagement and investigation, encourage interaction between faculty and students, and provide continuous feedback on student performance. Teaching with technology is an appropriate choice only if it supports these essential pedagogical goals.

NC State has two units that are directly involved in instructional development, the Learning Technology Service and the Faculty Center for Teaching and Learning. Each unit has its distinct strengths, and they collaborate in ways that benefit teaching and learning with technology at NC State.

Current collaborations include the Teaching with Technology seminar series; joint development of a workshop on inquiry-guided learning with technology; establishment of the Gertrude Cox Awards, recognizing excellence in teaching and learning with technology (with TLTR); and reciprocal membership on advisory boards.

The Learning Technology Service

The LTS provides faculty and staff with regularly scheduled and customized workshops, instructional consultation, and a wealth of Web-based and print resources. In 2002-03 the LTS scheduled 236 sections of 53 different workshops. These workshops served 1,829 participants.

Two years ago, the LTS began offering custom training sessions to faculty, staff, and graduate students engaged in on-line or technology-enhanced instruction. In 2002-03, the LTS served 126 participants in custom training and 69 participants in overview sessions. Consulting services were offered by phone and e-mail, and staff began to make instructional house calls to provide in-depth assistance to faculty members either in their office or in the DELTA offices. Last year, the staff answered 1,101 e-mails, phone, and in-person help calls and consultations, representing an increase of almost 61 percent over the previous year.

Special programs include the Teaching with Technology Seminar Series, the Summer Institute, and the Instructional Technology Assistant Program. All of these programs offer assistance to faculty in the pedagogical, technical, management, and policy aspects of Web-based instruction.

The Faculty Center for Teaching and Learning

The FCTL offers an array of programs including instructional and curriculum development, new faculty and graduate student development, and the evaluation of teaching. The center has been very active in the campus's growing culture of assessment and in the evolving LITRE plan.

The FCTL facilitates and supports excellence in teaching and enhances student learning by

- promoting a campus culture that values and recognizes the importance of teaching excellence and student learning;
- promoting the development of faculty and teaching assistants in knowledge, techniques, and skills of excellent teaching and enhanced learning;
- cooperating with and supporting other efforts at NC State that share this mission.

Disciplinary-specific training and support services

NC State also supports training, development, and support opportunities for faculty at the department and college level, where instructors are actually using a variety of technologies to promote learning. In part the rationale for this is logistical—providing support in proximity to its use. Technology is not effective if it isn't functioning properly, and we need trained technical support where the technology is being used. But it also relates to the particular character of the disciplines. While there are general principles of teaching and learning, each discipline is also unique and has a body of pedagogical content knowledge appropriate to it. This pedagogical content knowledge represents a kind of lore of teaching in the discipline that covers strategies for presenting concepts students find particularly difficult, effective analogies, traditional teaching practices known to be effective (e.g., studio method), and others.

Technology training and support for students

University Planning and Analysis conducts a variety of surveys over the course of students' tenures at NC State. A number of questions on these surveys relate to students' computing skills and the resources available to them. The results provide a snapshot of the current state of student computing skills and support at NC State.

On freshman surveys conducted during New Student Orientation, incoming students consistently rank the importance of developing computer skills as the highest of the twelve listed general education goals. Over the years, students' self-assessment of their own computer skills has steadily improved, though some continue to rate their skills as low.

UPA's biannual survey of sophomores asks students to rate thirty-five different campus services. Respondents gave high ratings to physical technology services available on campus such as access to the Internet, facilities, and hours of operation. *Access to the Internet* received the highest average rating of the thirty-five services, with 77.3 percent of respondents to the most recent survey rating access as excellent. The lowest average ratings were given to *access to trained staff for help*, and *access to technology training classes*.

Graduating seniors are asked to complete a survey about their experiences at NC State and to rate their experiences with campus services. Seniors, too, rated access to the Internet and facilities high, but access to trained staff and technology training classes low. On the other hand, among thirty-five general education goals listed, respondents gave the fourth highest ranking to the *development of computer skills*. While help and training are not as readily available as students would like, they still feel their computer skills are being enhanced.

NC State seeks to ensure that students are equipped to interact effectively with the technology-rich learning environment we supply. In some cases, remediation is necessary. In other cases, it is necessary to supply just-in-time support and training for students who experience technology as a barrier, rather than a bridge, to learning. Training and support programs for students have three overarching goals:

- Ensure that new students are prepared to meet technology-use expectations.
- Integrate technology-enhanced learning with the core academic activities of the university as judged appropriate by the faculty.
- Ensure that graduates leave the university with appropriate technological proficiency to be able to use technology appropriately for a lifetime of intellectual discovery, personal development, and community service.

(For a full list of criteria for judging student information fluency at various levels, see appendix C.)

Entering students

Students entering NC State are expected to carry out basic skills and understand core concepts about information technology that will allow them to meet expectations initially placed on them by the faculty and the university environment. These skills and core concepts are the basis upon which students use technology to learn within and outside of the disciplines. Refining that list of skills and expectations based on faculty expectations is a part of the LITRE plan.

Some requirements, however, are unassailable. Entering students must be able to

- communicate electronically;
- create electronic documents and visual presentations;
- use electronic tools for data analysis and visualization;
- locate and critically evaluate appropriate information resources;
- use information effectively to accomplish a purpose.

While the definition of which technology skills are necessary to succeed may change over time, entering students must have an understanding of information and technology concepts that are much less subject to change. For example, a conceptual understanding about computer systems includes understanding that they are made up of physical components (hardware) and programming or code (operating systems, applications), that a computer is capable only of doing what it is programmed to do, that it contains various input and output interfaces, etc. A conceptual understanding of on-line information resources includes knowing the difference among, for example, library catalogs, bibliographic databases, electronic journals, Web search engines, etc.

Current students

As students progress through the university, the emphasis on technology and information proficiency is less on learning how to use a particular piece of technology and more on using the technology to enhance learning.

Continuing students integrate appropriate technology-enhanced learning by carrying out a variety of activities related to their area of study. Here, faculty input is critical. Students develop independent computing software skills by applying previous conceptual understandings, using manuals, tutorials, and on-line resources. They apply existing and newly learned skills to the work of the discipline through a variety of means, including exploring appropriate discipline-specific databases and search engines, analyzing and manipulating discipline-based data in numerical and/or visual form, choosing appropriate applications for specific tasks by making critical evaluations of the “goodness of fit” between software capability and information goals, and using information technology legally and ethically.

As appropriate, students also use technology to collaborate on the work of the discipline with fellow students, faculty, librarians and other staff. They may participate in class chat environments, prepare in-class demonstrations, access discipline-specific databases linked to course instruction (e.g., slide collections, lab-reporting Websites), or take a full course or components of a course on-line.

While the focus on technology proficiency for new students centers on computer technology, the skill set for continuing students often shifts to non-computing technology required to do the work of the disciplines (e.g., science labs, design studios, various types of shops). Students may use non-computing technology to conduct experiments; develop prototypes or models that describe physical or abstract relationships; determine the performance or behavior of materials, forces, or other physical phenomena; or they may even invent new forms of technology.

Finally, current students develop means to document their performance over time. This may include the use of electronic portfolios, physical portfolios, presentations, or capstone projects.

Graduating students

As a result of the integration of technology into their learning experiences, graduates leave the university with the necessary technological proficiency to allow them to succeed. They can use technology for entry-level employment in their chosen field, identify appropriate information sources and use appropriate search mechanisms of information databases in their field, make intelligent choices among competing technologies, and maintain currency in technology applications through the skills and knowledge they developed as students. As graduates seek employment or further education, they can use technology to compile summary presentations of their knowledge and skills based upon the work they did. Finally, the exposure to technologically enhanced learning allows them to approach the acquisition of new technology skills with confidence, regardless of their career path.

Distance education and distributed learning

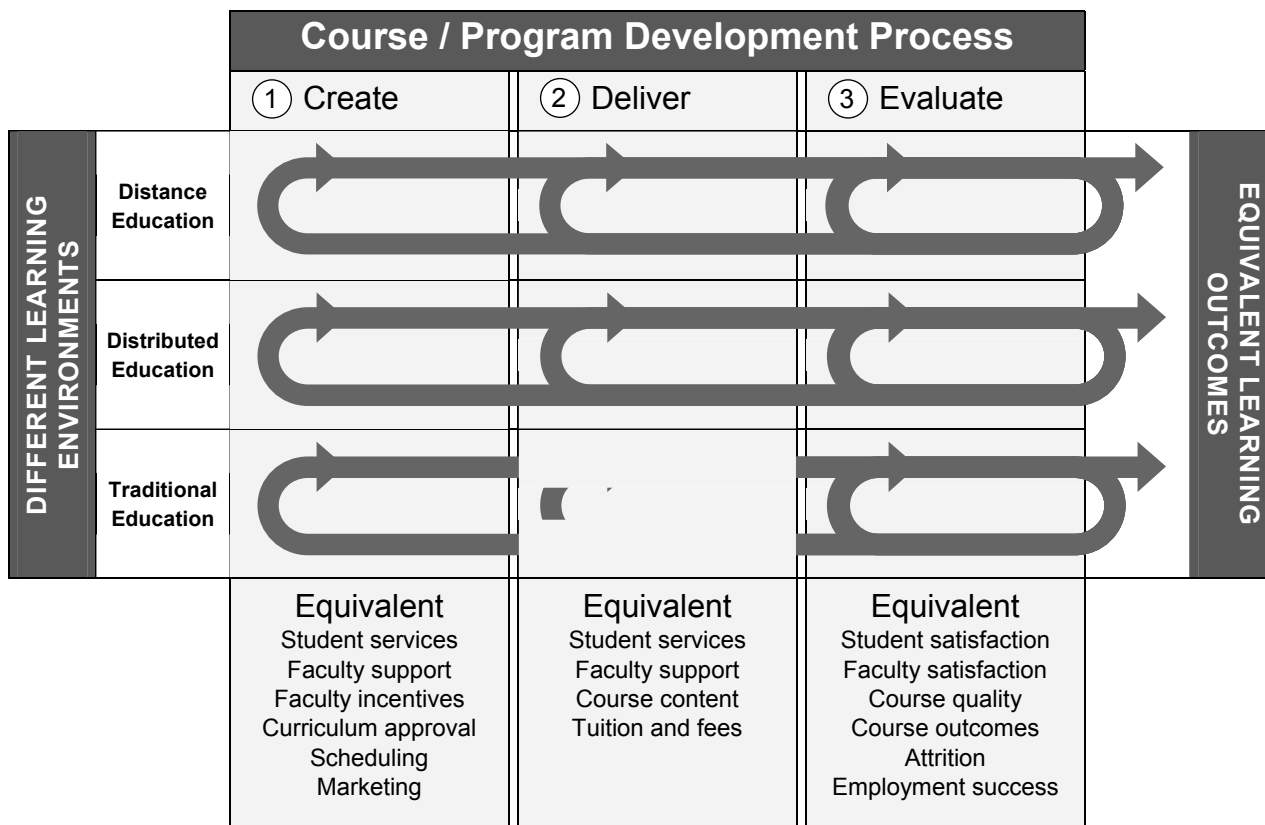
NC State's rich learning environment supports a range of different course delivery methods. At one end of the spectrum is traditional face-to-face instruction, bound by constraints of time and place. At the other end is distance education, which can be accessed by students at any time, from any place. In between is distributed learning, in which instructors select appropriate technologies to enable them to achieve the learning outcomes they have set.

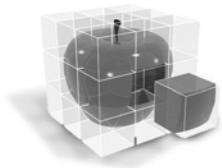
From the university's point of view, the touchstone is student learning outcomes, which must be equivalent regardless of method of delivery or technology enhancements.

Both distance education and distributed learning models are built around the central components of the basic instructional process: presentation of content, interaction between students and faculty, peers, and resources; practical applications; and evaluation. To ensure that learning outcomes are equivalent regardless of course delivery method, all aspects of course creation, delivery, and evaluation must be equivalent.

The following graphic lists the tasks of each phase of course development. Equivalency in these tasks is necessary to produce equivalent learning outcomes.

Equivalency across Learning Environments
Elements for consideration during course and program development phases





CHAPTER 2

NC State's Technology-Rich Environment

North Carolina State University has an impressive technology infrastructure on which to build. Current annual expenditures on educational technology total more than \$30 million, and many of our technology investments are capital projects that will continue to serve the university long into the future.

Physical facilities

NC State's core campuses—the Main Campus, the Centennial Campus, and the Veterinary Medicine Campus—and other facilities statewide include 1,061 buildings representing a current replacement value of more than \$1.2 billion and comprising more than 6.9 million square feet of space. The three campuses contain most of the university's teaching and research activities.

Classrooms

NC State has 247 general-purpose classrooms, containing about 213,000 square feet of space, and approximately 14,000 student stations. Although the classrooms are scheduled centrally by Registration and Records, individual colleges or departments have scheduling priority for all but thirteen of the rooms.

Of the 247 classrooms, approximately 85 have some form of audiovisual equipment beyond the overhead transparency projector that is standard in each room. The additional equipment in these rooms is provided and maintained by the academic unit that has scheduling priority.

The university maintains twelve teleclassrooms and videoconference rooms on the NC State campus that are connected to the North Carolina Research and Education Network (NC-REN) and other NC State video facilities via the university campus fiber-optic network. A media production facility provides master-tape inventory control, quality control, and duplication services for distance education course materials. Additional teleclassrooms will be built with funding from the 2000 bond referendum.

In fall 2002 the division of Facilities Planning and Design, in conjunction with many other campus units, completed new design standards for classroom technology. These standards established five levels of classroom-technology design and specified the equipment to be available at each level. An initial stage of addressing these standards is NC State's ClassTech pilot project, which brought twelve classrooms on Main Campus up to the new technology standards in early 2004.

Computer labs

High-speed Internet access is available to students from more than 2,800 workstations in 107 computing labs on campus. Eight Unity computing labs (over 300 workstations) are open to students of all colleges. Unity labs are equipped with a mixture of Windows, Unix, Linux, and Macintosh workstations, all of which provide direct access to file space, software, and other resources of the Unity computing environment.

Individual colleges also support their own computing labs. Most workstations (over 1,800) in college-supported labs also use basic Unity desktop environments, modified to meet the particular needs of the college's curricula. All Unity labs and most college labs are equipped with assistive technology (hardware and software) to provide equitable access to technology resources for students with disabilities.

The NCSU Libraries provides almost 200 desktop computers and 147 laptops for student and faculty use. These computers provide access to the Internet and library resources, but not to all the resources available in the Unity environment.

Data network

The campus high-capacity fiber-optic network backbone consists of a multi-link gigabit Ethernet mesh among five main distribution facilities. The NC State University Main Campus, the College of Veterinary Medicine campus, Centennial Campus, and 95 percent of campus buildings have fiber-optic connections to the network backbone. All thirty-four campus residential halls, fraternity and sorority houses have port/pillow switched Ethernet connections.

In addition to Internet access, the campus backbone connects to the North Carolina Research and Education Network and to the regional North Carolina Networking Initiative backbone at two locations. The NCNI backbone is being upgraded to provide NC State and other regional research universities with access to capacities exceeding even those of Internet2. NC State is a charter university participant in Internet2 and home of one of two national Internet2 Test and Evaluation Centers.

Mobile computing and the wireless network environment

NC State's wireless system is currently being expanded campuswide according to a students-first plan. The university uses the 802.11b standard, also known as Wi-Fi, for its wireless computing environment. The wireless infrastructure is based on the university's Nomadic computing system, which now has over 800 ports where users can plug in laptops and authenticate to the campus network. D.H. Hill Library was the first campus building to implement Nomadic computing, followed by Nelson Hall and Talley Student Center.

Facilities planning and the 2000 bond referendum

In 1999, to ensure an accurate, independent assessment of existing facilities and plan for future needs, the UNC Office of the President hired a consultant to prepare a comprehensive "Facilities Profile and Ten-Year Capital Plan for The University of North Carolina." The study examined the resources and summarized all facilities-related information and capital needs of the system's sixteen constituent institutions.

To address the facilities needs outlined in the ten-year capital plan, UNC planned a multi-phase, higher education bond referendum. Phase I of the bond referendum was passed by the voters of North Carolina in 2000. It provided over \$468 million for NC State to build new facilities and upgrade those facilities already in place. The university is adding over \$57 million from gifts and other sources to the bond funding for a total of over \$525 million in new capital spending. This funding is in addition to \$480 million of other construction projects in progress.

Guiding this development is the NC State University Physical Master Plan, which was most recently revised in 2000. The physical master plan outlines a vision, guiding principles, design guidelines, and construction guidelines for renovations and new construction across campus that accommodates planned growth in enrollment and research programs.

At a time when many universities are retrenching due to poor economic conditions, the funds provided by the bond referendum have enabled NC State to move steadily forward in its building and renovation programs.

The academic computing environment

NC State's campuswide multi-platform (Windows, Unix, Linux, and Macintosh) academic computing environment is known as Unity. At a minimum, all NC State faculty, staff and students automatically receive a computing account with Unity privileges. Unity computing accounts include e-mail services, an allocation of personal file space, support for personal Web pages, and access to approximately 550 Unity software applications. The software ranges from screen readers and other assistive technologies to Web-authoring tools. As of April 2003, there were almost 52,000 active Unity accounts (students, faculty, full-time and part-time staff combined).

Unity is a distributed client-server network running AFS, a location-independent file system that delivers software to three platforms: Windows 2000, Sun Solaris 8, and Red Hat Linux 7.3 and 9.0. AFS is the shared file space in which users move around. Users can log into the Unity system from any Eos/Unity workstation.

The authentication system is Kerberos, developed in MIT's Project Athena. Users can customize the Unity environment as they like, and it is downloaded whenever they log in to any machine on the network.

E-mail services

All students, faculty, and staff automatically receive Unity e-mail accounts. In an average month Unity e-mail servers deliver more than 13 million messages. NC State also supports e-mail list services for faculty, staff, and university organizations. The WolfWare course management system provides additional e-mail list services so that faculty can conveniently set up mailing lists for their courses.

Web servers and services

NC State's Websites provide course material as well as information and services for campus and global audiences. Supported sites include www.ncsu.edu, webct.ncsu.edu, courses.ncsu.edu, webassign.ncsu.edu, wolfware.ncsu.edu, search.ncsu.edu, and virtual hosting services for the sites of most colleges.

The Web systems supported by the Information Technology Division use e-commerce-quality Sun Ultra and Netra-class computers, 100 MB Ethernet connectivity, and the university's network-based AFS file system. The reliability and performance of NC State's servers consistently rank above industry standards (as measured by Keynote).

Some campus organizations support their own Web servers. For example, the North Carolina Cooperative Extension—one of the university's major extension and engagement services—houses 12 gigabytes of data and in 2002 averaged 15,000 visits to the site each day.

High-performance and research computing

In response to the May 2003 reorganization of the North Carolina Supercomputing Center, NC State entered into a cooperative arrangement with Duke University, UNC-Chapel Hill, and the UNC Office of the President to build on-campus high-performance computing resources, develop the regional networking infrastructure necessary to participate in national HPC and grid initiatives, and provide researchers with access to national supercomputing centers. The HPC program was initiated in July 2003 with the installation of an IBM p690 computer to serve the high-end computing needs of research programs ranging from astrophysics to particle hemodynamics. The service is available to all North Carolina higher education institutions. Additional resources will be installed in the near future.

Support for educational technology: Centralized units

The university employs a distributed organization to provide information technology services. This approach enables the central academic and administrative IT units to provide sophisticated systems and services for all colleges. In addition, each college maintains its own IT support unit to provide additional resources to meet its specific needs.

Centralized support units include the Information Technology Division and the Distance Education and Learning Technology Applications division.

Information Technology Division

The Information Technology Division, under the Office of the Provost, provides leadership and support for the university's academic computing and networking resources. To anticipate and prepare for rapidly advancing technology, ITD employs non-line-management subject-matter experts responsible for forecasting needs and re-engineering processes. ITD has responsibilities in three broad categories:

- **Academic computing support services**, such as technology user support, campus help desk services, consulting, training, workshops, and services in support of college technical staff. Other services include on-line and CD-based instruction and Help!, a database of 2,500 previously asked questions about computing at NC State. The ITD help desk logged, resolved, or otherwise handled more than 17,000 calls for technical help in 2002.
- **Large-scale, commodity production IT services**, including the campus data network infrastructure, operational support for academic and administrative servers and mainframe computers, campus Web and e-mail services, and Unity, the campuswide academic computing environment.

- **Applied research and development of high-end production services**, to implement information technologies required to advance the university's research, teaching, and outreach missions.

Distance Education and Learning Technology Applications

DELTA provides leadership and support for technology-mediated teaching and learning, whether at a distance or on the campus. DELTA includes two major units: Distance Education, and the Learning Technology Service. Distance Education delivers learning programs to NC State's diverse and dispersed community of learners. The Learning Technology Service supports the integration of technology, teaching, and learning at NC State.

DELTA provides education infrastructure and support including

- upfitting, managing, and coordinating the university's distance education classroom facilities and video infrastructure;
- developing, supporting, and integrating the university's learning management systems (e.g. WolfWare, WebCT);
- providing instructional design, multimedia development, and Web development services for academic content production;
- developing and supporting NC State's distance education student portal;
- training faculty, staff, and students in teaching and learning with technology;
- providing media production and distribution services for distance education;
- supporting the development of new distance education programs, courses, and resources through the competitive IDEA Grants program;
- coordinating the university's distance education enrollment planning and projections;
- providing distance education student services, through partnership with Credit Programs and Summer Sessions.

Support for educational technology: College-based

Of the \$30 million that NC State spends annually on information technology, approximately \$20 million is spent at the discretion of NC State's ten colleges. Each college employs support staff for IT learning and information resources. Their tasks include support for student computer labs, discipline-specific software, teaching and learning with technology, and direct desktop support for faculty and staff. The focus of responsibilities varies among colleges and departments according to the needs of individual disciplines. Funding levels vary according to student enrollment and the technology requirements of specific disciplines. Expenditures are highest in colleges heavy in technology content (e.g., the College of Agriculture and Life Sciences, the College of Engineering, and the College of Physical and Mathematical Sciences).

The Educational and Technology Fee

A major source of funding for college-based technology is the educational and technology fee, which is paid by students in addition to their regular tuition and is distributed to the colleges at the discretion of the provost.

The ETF provides

- campuswide student computing services;
- equipment, supplies, and maintenance for departmental labs with specific curricular objectives.

Students at NC State have consistently supported the educational and technology fee, even in times of rising tuition rates and other financial pressures.

College of Agriculture and Life Sciences

CALS is interested in how faculty use technology in teaching and how facilities can be upgraded to provide cutting-edge teaching opportunities. The Academic and Administrative Technology unit provides technical support and consultation for those who wish to convert courses to distance education or on-line courses.

Approximately one third of all CALS ETF dollars are used to support student computing facilities, including fourteen student computing facilities and ten smaller facilities. The college also supports twenty multimedia classrooms.

College of Design

Information technology media are central to the practice of design. Each design student is required to complete eight design studios that deal with the application of an array of media, including use of computer media to solve design problems. Design studios are inquiry-based, collaborative, active learning experiences.

To ensure that all students have access to information technology resources and technology-enabled course content, the college provides computers for College of Design student use in three instructional computer laboratories. The college also supports two auditorium classrooms equipped for projection of computer applications.

College of Education

To ensure that students are exposed to multiple platforms, the college supports both Windows and Macintosh-based computers. This exposure enhances the development of a technology-acquisition heuristic and exposes students to the tools of their profession. Extensive multimedia authoring, statistical, and 3-D rendering software is available.

The college has five general-use teaching labs and two specialized labs: one for digital audio and video, one for transportation technology. All the general-use labs are equipped with digital projectors and smartboards. The college recently upgraded three computer labs to provide desktop power outlets for laptop-based courses, workshops, or students' personal machines. All classroom space in Poe Hall is covered by the campus Nomadic wireless service.

In addition, the college has one mobile classroom cart equipped with Windows and Macintosh computers and a digital projector.

College of Engineering

The use of technology is an important content area in engineering. The CoE supports three platforms (Unix, Linux, and Windows), sixty commercial engineering software packages, and numerous other non-commercial software packages.

The Student-Owned Computing Initiative is an excellent example of how the college integrates technology into the classroom. Incoming freshmen participating in the SOC Initiative are block-scheduled into classes where instructors have integrated computers into their courses. Integration of computers into upper-division courses is being piloted with classroom-based CoE laptops, housed in a laptop cart.

The college supports thirteen multimedia classrooms, with facilities ranging in scope from just an overhead projection system with a telecommunication connection to full-blown multimedia classrooms.

College of Humanities and Social Sciences

CHASS believes that individual departments are the appropriate judges of how best to use technology to enhance student learning, and that they should base those decisions on the specific goals of programs and curricula. The college attempts to ensure a basic level of information fluency. For example, instructors in the freshman composition program collaborated closely with the NCSU Libraries to develop the award-winning Library Online Basic Orientation tutorial.

CHASS has two multimedia classrooms and five student labs.

College of Management

CoM supports hardware and software that students will typically use in the workplace. The choice of the software and hardware is thus driven by the market.

All Nelson Hall classrooms are multimedia classrooms. Classroom equipment includes a touch-screen master control panel, a LCD projector, computer, VCR, sound amplifier, speakers, lighting controls, motorized projection screen, and motorized window shades. Seven of the multimedia classrooms are set up for student use of laptops.

The college provides an undergraduate lab area that includes a walk-in lab, teaching lab, and auxiliary lab (used for walk-in or teaching). There is also a graduate lab for MBA students, a graduate lab for accounting students, and a studio lab for e-commerce students.

The college supports several large Websites, built and maintained for CoM courses in e-commerce, supply chain management, technology and commercialization, and innovation management.

College of Natural Resources

Each department in the college determines the appropriate application of technology to enhance student learning, based upon disciplinary goals. The majority of software used within the college operates on the Windows platform. The college supports approximately twenty application software packages, including the ESRI family of geographic information systems (GIS) software required in the various disciplines.

All six of the college's classrooms meet (or parallel) proposed classroom standards for multimedia computing. CNR provides two computing labs and supports two departmental graduate student computing labs as well as graduate-student office computing.

College of Physical and Mathematical Sciences

The use of technology is an integral part of students' academic experience in all PAMS curricula. Platforms and applications use are driven by the specific requirements of individual curricula.

Within the college, Unix, Linux, Windows, and Macintosh platforms are available, as are over 500 applications. The college maintains eleven computing labs for student use, and has equipped several facilities with computers and additional technology as classrooms/labs.

Most PAMS departments have multimedia tutorial centers for students to seek supplemental instruction. Training programs are available for faculty, staff, and students in the use of Maple, MATLAB, and the High Performance Computing Facility's Beowulf cluster.

College of Textiles

The college supports a general computing lab that runs the general university-provided software applications. Several special-purpose labs offer hardware and software specific to the textile industry.

- The Digital Design Lab is equipped with fabric design software. Some of the design software systems are networked to manufacturing equipment, providing a Computer Integrated Manufacturing capability. Other systems are interfaced with body scanning capabilities.
- The Textile Engineering Lab is equipped with engineering software such as AutoCAD for design and Minitab for statistical analysis.
- The Color Lab supports several systems that are interfaced to color-measurement systems.
- The Apparel Manufacturing Lab is equipped with apparel manufacturing software for both designing and manufacturing garments.
- The Apparel Design Lab is equipped with various apparel design software packages.
- The Textile Engineering Linux Lab is used for programming classes.

College of Veterinary Medicine

The college's Mobile Computing Initiative is its most comprehensive effort, to date, to enhance student learning across the curriculum. In this program, the college purchases Palm OS-based personal digital assistants (PDAs) and distributes them to third-year students, who carry the devices on through their clinical experience in their fourth year. The program is designed to improve animal health through better access to medical information and to train students to make use of available technologies.

The CVM provides technology-enhanced teaching environments in all four of its major classrooms. Several of these rooms also support distance education.

The NCSU Libraries

The NCSU Libraries maintains a collection of more than 3 million volumes, for which expenditures are more than \$8.7 million annually. North Carolina State University, Duke University, the University of North Carolina at Chapel Hill, and North Carolina Central University form the Triangle Research Libraries Network (TRLN), with combined resources of more than 14 million volumes and collections budgets totaling more than \$29 million.

The Libraries maintains numerous data collections, a federal depository library, a patent and trademark depository library, and a depository for documents from the state of North Carolina. The Libraries participates actively in organizations that explore leading issues related to collections at the national level.

Electronic resources

The NCSU Libraries is a leader in exploring how technology can enhance access to its information and learning resources. An on-line catalog facilitates integrated access to both the print and electronic resources in the Libraries collection. Over 200 on-line databases are available for searching via the Libraries Website; users can choose one or more databases by subject with the Database Finder. The heavily used electronic reserve service provides access to course materials such as class notes, exams, homework assignments, journal articles, and book excerpts.

The Libraries invests significantly in electronic resources. In FY 2001-02 the Libraries expended over \$1.4 million for electronic resources, providing its users with access to over 24,000 electronic books, 8,368 electronic journals, and 279 electronic databases. Electronic materials comprised 22 percent of the Libraries' materials budget.

To ensure that its electronic resources are easily accessible, the Libraries maintains a robust proxy server that allows remote authentication from any location. Anyone with a NC State computing account can access the electronic collections remotely.

Information-literacy support services

The NCSU Libraries offer a full range of programs to provide instruction in the use of the library for faculty, students, and staff. Librarians work closely with faculty in developing instruction sessions, constructing Web pages that organize information sources and creating library research assignments.

The Libraries provides many ways for faculty and students to request assistance: in person, by telephone, by electronic mail, or via chat sessions on the Web.

The NCSU Libraries has numerous Web-based instructional offerings, and they are used heavily. Examples of instruction on the Web include Library Online Basic Orientation (LOBO); a virtual tour of the main and branch libraries; introductions to Geographic Information Systems, Educational Resources Information Center (ERIC), and other electronic resources and tools; and numerous guides for locating information in a variety of formats and disciplines.

Labs, laptops, and wireless networking

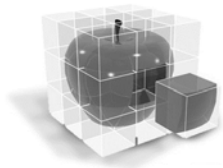
Currently, the NCSU Libraries provides access to almost 200 computers in labs. In addition, it provides laptop computers for in-building use. The laptops include 22 Macintosh laptops and 125 Dell PC laptops running either Windows 2000 or Linux OS.

Wireless networking is available in several areas of the main library and in branch libraries. The Libraries lends wireless network cards for use within the building.

The Learning and Research Center for the Digital Age

In accord with its commitment to educate faculty and students about new information technologies, in 2003 the Libraries opened the Learning and Research Center for the Digital Age. The LRCDA offers workshops, consultation, and technology-related services directly to faculty and students, and includes the following services:

- The Digital Library Initiatives Department leads the library in creating new digital services and collections, with an emphasis on exploring and testing new technologies.
- The Information Technologies Teaching Center provides three teaching labs where the Libraries, LTS, and Computing Services offer hands-on instruction in the latest software, hardware, and communications technologies.
- The Faculty Development Services unit of the Learning Technology Service works collaboratively with faculty, staff, and graduate students to support teaching and learning with technology.
- The Digital Media Laboratory provides equipment, software, and assistance for creating digital materials and converting all types of media to digital formats.
- The Usability Research Laboratory offers state-of-the-art equipment capable of collecting video, audio, and computer data from the user in real time for observation and analysis.
- The Multimedia Seminar Center is a presentation and seminar facility with videoconferencing and projection capabilities (in development).
- Through workshops, seminars, and consultation, the Libraries' Scholarly Communication Center serves as a resource on scholarly communication issues such as copyright and fair use as they relate to library collections and services. Its staff includes a copyright and intellectual property law specialist.
- The Collaboratory is a computer-equipped collaboration room for small groups working on digital projects.
- Assembly Room provides conference and presentation space for groups using any of the other facilities in the LRCDA.



CHAPTER 3

Preliminary Research

To address the work of LITRE, the LITRE team established a steering committee and five focused research groups.

LITRE Steering Committee

The LITRE steering committee kept the LITRE team focused on student learning. The group prepared goals, objectives, and strategies to complete a quality enhancement plan for SACS reaffirmation in 2004. The steering group was also responsible for communicating with and educating the NC State community about LITRE issues. Steering group members were leaders of LITRE research groups (see below) and/or representatives to key partners to the accomplishment of the LITRE charge, such as the Faculty Senate, the Teaching Learning Technology Roundtable, and the Council on Undergraduate Education.

Educational Infrastructure Research Group

This group reviewed the planning, design, and maintenance of instructional technology facilities and systems that support student learning, such as classrooms, computer labs, media equipment, linking systems, campuswide servers, testing services and systems, and learning management systems. While respecting the unique needs of each discipline, the group addressed the need for a collaboratively developed, university-wide technology infrastructure that builds on existing educational technology resources and invests in specific emerging technologies. The goal is to create a seamless learning environment that is appropriate, reliable, integrated, supported, and sustainable.

Student Information Fluency Research Group

This group examined methods to ensure that all learners at NC State have outstanding comprehension and skills relative to technology-rich learning. The group defined strategies to support NC State students as they enter the university and navigate through their academic programs, improving their technology fluency across the curriculum. The goal is to produce NC State graduates who are prepared to be competent and ethical lifelong learners, responding to, embracing, and readily adapting to change, whether in their professions or in other aspects of their lives.

Faculty Engagement Research Group

This group examined support structures that empower faculty to use effective and appropriate learning technologies in their teaching. The group examined current faculty-development activities and recommended additional activities to promote effective technology-facilitated teaching and learning. In addition, the group developed guidelines for evaluating faculty contributions related to enhanced learning through technology, including suggestions for reappointment, promotion, and tenure committees. The goal is to develop the faculty's active involvement with questions of how best to promote student learning.

Learning Resources and Educational Technology Applications Research Group

This group examined the content of NC State's technology-rich learning environment, including digital learning resources and educational technology applications that faculty and students use to support their research and study. Focuses included licensing and copyright; and the acquisition, development, maintenance, support, and integration of digital information collections (data sets, images, audio and video, journals, multimedia learning resources, learning objects, and much more) and core educational software.

E-learning Environments Research Group

This group examined strategies for developing, maintaining, and promoting creative, innovative, and pedagogically sound technology-rich instruction (modules, courses, programs) both at a distance and in distributed learning environments. The group examined the effect of current funding, evaluation, and support

practices on NC State's ability to deliver high-quality education across a range of delivery systems. The group recommended strategies for ensuring the equivalency of learning outcomes.

Research foundations

To launch LITRE's scholarly inquiry, LITRE's research groups were charged to begin their investigations by asking not "Where are we now?" but rather "Where do we want to be?" The answers that the groups developed constitute a broad vision of an optimal technology-rich learning environment for NC State.

The following list is a compilation of the foundational work of the five research groups. This work was vetted across campus and was the basis of the research chairs' presentations at the April 2003 LITRE Campus Forum.

NC State's optimal learning environment

To achieve the LITRE vision, North Carolina State University must develop and maintain a technology-rich environment that provides effective enhancement to learning. An optimal learning environment should address:

FACILITIES

On-campus learning environments

- Review minimum classroom quality standards regularly to ensure that they meet a standard judged appropriate by the faculty.
- Support faculty-driven initiatives that define and evaluate classroom features.
- Upgrade classrooms, labs, and work areas when appropriate to meet the needs of faculty who have special teaching needs.
- Provide classroom and lab equipment appropriate to the needs of individual disciplines and classes.
- Provide sufficient funds and personnel to maintain classrooms, labs, and equipment.
- Ensure that classroom, lab, and equipment quality standards are met and maintained.
- Ensure that facilities and courses accommodate students with physical limitations and diverse learning styles.

On-line learning environments

- Provide Internet access from classrooms and labs at a level judged appropriate by the faculty.
- Provide Internet access from non-classroom areas, including the library, popular campus gathering areas, and campus residences.
- Ensure that the university community can access academic services and software applications from off-campus.
- Provide sufficient file space for work-product storage.
- Ensure appropriate security in all systems.

TOOLS

Hardware

- Articulate minimum standards for computing owned by students, including distance learners.
- Provide faculty with computers that are compatible with computers owned by students.

Software

- Improve coordination of software licensing to address compatibility issues and version control.
- Address resource-allocation issues for software that is used by multiple colleges and units.
- Develop a complete software inventory listing the software available in all labs, associated technical support, and negotiated prices for university employees and students.
- Study the impact of open-source software and university/industry alliances.

Learning resources

- Provide standard university-level services, such as Web, e-mail, calendaring, student portfolios, course management, and course assessment.
- Investigate digital-asset management system issues and available products, examining the costs, benefits, and technical infrastructure options.
- Provide an array of tools and learning objects to enhance teaching.
- Develop strategies for reducing student cheating and plagiarism.
- Ensure accessibility of learning resources for individuals with disabilities.

TRAINING AND SUPPORT

Student technological fluency

- Ensure that new students are prepared to meet technology-use expectations.
- Integrate appropriate technology-enhanced learning with the core academic activities of the university.
- Ensure that graduates leave the university with appropriate technological proficiency so that they are able to use technology appropriately for a lifetime of intellectual discovery, personal development, and community service.

Faculty engagement

- Develop a comprehensive grant, leave and recognition program to support teaching, learning, and technology development activities for individual course development and department-level curriculum work.
- Conduct a campuswide needs assessment to identify training needs in the area of teaching, learning, and technology.
- Provide coordinated training and development opportunities in teaching, learning, and technology applicable to a range of distributed learning environments.
- Provide mentoring, coaching, custom training, and logistical support at the department level in the area of teaching, learning, and technology.
- Create and promote forums at both the university and department levels that encourage discussion about teaching, learning, and technology.
- Provide a comprehensive program of training in teaching, learning, and technology for doctoral students.

Technical support

- Provide sufficient technical support for both hardware and software.
- Provide sufficient technical support for students, faculty, and staff.
- Hire and maintain sufficient technical personnel to support and develop the technology infrastructure, including the installation, management, maintenance, and operation of campus Internet resources and file servers.
- Improve communication between software-support staff and faculty and students about software-upgrade schedules and significant differences among campus lab configurations.
- Expand help-desk services, with due consideration for the relationships among academic, administrative, and college-based computing help.
- Develop a seamless technological environment to support teaching and learning. This would include the coordination of campus units responsible for academic computing, the development of a Web-casting infrastructure, and portal development, along with active communication among the key stakeholders.

Libraries

- Expand curriculum-integrated information-literacy instruction.
- Develop, implement, and evaluate a model for assessing learning outcomes resulting from information-literacy instruction.
- Engage in partnerships to deliver instruction and content enhanced by new learning tools and technologies.
- Promote the Libraries' Learning and Research Center for the Digital Age as a place for faculty and students to develop skills, integrate content, and design digital materials.

POLICIES

Reappointment, promotion, and tenure

- Recognize teaching, learning, and technology as an area of excellence in reappointment, promotion and tenure decisions.
- Establish clear guidelines for demonstrating excellence in teaching, learning, and technology.

Copyright

- Educate faculty, students, and staff about the provisions of NC State's Copyright Use and Ownership Policy, and develop amendments to that policy as appropriate.
- Establish clearly delineated and responsive authorities and processes for resolving questions related to permissions, licensing, nonprofit educational use, and commercialization of works.
- Devote staff time and expertise, based in Academic Affairs, to manage the investigations of the Copyright Committee.
- Establish a clear process for third parties to request and receive prompt permission to use works owned by NC State.

- Support and educate faculty and students so that they can produce on-line course materials that comply with the recently enacted TEACH Act.

Distance education

- Mandate accountability for distance education courses to home departments and colleges. This includes course creation, delivery, and evaluation.
- Revise NC State's tuition system to enable resident students to take distance education courses as part of their regular course loads.
- Ensure that colleges and departments reinvest funds generated by distance education in distance education programs.

Accountability

- Help faculty, staff, and students assess the impact of technology on learning.
- Ensure that technology systems and initiatives enhance learning.
- Use assessment results to redefine technology standards.
- Assess initiatives and programs by weighing benefits against costs.

2003 LITRE Faculty Survey

To amass data on the current state of technology-enhanced instruction at NC State and establish baseline data for further LITRE initiatives, the LITRE team developed a faculty survey. Distributed in spring 2003, the survey asked all NC State faculty who had taught in the previous semester about their experiences with computer-based instructional and learning aids. The LITRE team regarded the unusually large response rate of 55 percent (983 respondents of the 1,790 faculty surveyed) as solid evidence of high campuswide interest in the LITRE topic, and the data as dispositive in identifying critical needs.

Around 50 percent of respondents reported using at least one of the technologies listed by the survey in their classrooms. Of the technologies that were used, static electronic presentation by the instructor (e.g., PowerPoint) was reported most frequently (55 percent). Other technologies commonly used were demonstrating Web materials (45 percent) and presenting course concepts by animation, multimedia, simulation, or other nonstatic means (40 percent).

A very high percentage of faculty reported that they used technology outside the classroom. Use of e-mail, chat rooms, bulletin boards, etc. to communicate electronically with students was almost ubiquitous (94 percent). There were also very high rates of having students prepare (80 percent) and submit (64 percent) work electronically, and use digital content resources (71 percent). These are also technologies that respondents expected students to know how to use before they enrolled in their classes. Less common, but still substantial, was the use of learning management systems such as WolfWare and WebCT (42 percent) and having students use course-specific software (31 percent). Respondents teaching large courses were more likely than others to report using learning management systems (58 percent vs. 38 percent).

If a respondent had not used a particular technology, a later section of the survey asked why. The most frequent reason for not using a technology was, "I do not find it useful to the course." On average, 50 percent of respondents gave this as one of their reasons for not using in-class technologies, and 45 percent gave it for not using outside-the-classroom technologies. This response was more common in some colleges than in others. The variation may reflect differences in pedagogical styles in various disciplines, or differences in the availability of building resources and technological support from college to college.

Respondents were asked what would make it easier to use the technologies that they did use in their courses. The most frequent responses were, "If they were available and supported in the classrooms in which I typically teach" (37 percent) and, "If I had more time to develop assignments or classes with these technologies" (36 percent). These compare to responses ranging from 8 to 29 percent for the other factors listed.

The survey interpretation team acknowledged that it would be inappropriate to interpret the survey in strictly technological terms. The results probably reflect a mix of technological, pedagogical, and resource issues. For example, faculty in small upper-level courses were more likely to report using technology than faculty in other kinds of courses (large lower-level, small graduate-level, etc.). This may be because smaller, upper-level classes generally focus on content in the major and are more likely to be held in classrooms with computer connections for all students.

An interesting finding is that the results of the survey challenge the common assumption that older faculty or faculty who have been teaching longer are less likely to use computer-based teaching/learning technologies than younger or “newer” faculty members. Respondents’ age and number of years on the NC State faculty have very little relationship to the number of technologies used in courses. Together, age and experience account for only 1.6 percent of the variability in the number of technologies that respondents used. Age and experience also have very little relationship to the number of technologies that respondents said they did not use because they did not find them useful for their courses.

Appropriate pedagogical choices

A bedrock requirement for LITRE is a faculty that make thoughtful judgments about the appropriate use of technology as a pedagogical tool. The LITRE vision statement acknowledges that “technology has limitations. It is a tool for achieving the university’s mission, not an end in itself. It is an effective tool only when it is in the hands of skilled users, and only when its application is appropriate, reliable, integrated, supported, and sustainable.”

Given this, the LITRE team took particular interest in the fact that the most frequent reason respondents gave for not using a technology was “I do not find it useful to the course” (50 percent). Faculty respondents elaborated on this response in the open-ended sections of the survey, which many respondents viewed as an opportunity to explain the specific pedagogical needs of their individual classes and disciplines. Respondent after respondent reminded the LITRE team that technology was only one of many available pedagogical tools, and that their choice of tools depended on their course content and objectives. As one respondent noted: “I believe in appropriate use of technologies. My area ... is inherently technology-rich. My selection of presentation tools and class activities is strategically made to meet my course objectives.”

More generally, another respondent noted: “Technology helps students learn in different ways. The old teaching methods are still valid—technology simply adds to our list of choices. ... For a new technology to replace an old one, it has to have all the advantages of the old methods but some new advantage, such as easier, cheaper, better, etc.”

Although most faculty respondents to the survey were open-minded about incorporating technology tools into their range of pedagogical choices, even the most tech-involved insisted that the adoption of those tools depended on course content. When technology tools presented clear benefits to achieving course objectives and enhancing subject matter, they adopted them enthusiastically. When such benefits were hard to find, they justifiably made other choices. The overall portrait is of a thoughtful teaching faculty actively involved in making informed, strategic pedagogical choices.

Availability in classrooms

One reason for not using any given pedagogical tool, of course, is that it is not readily available. The LITRE team took particular notice that a full 37 percent of respondents said that the reason they were not using technology-assisted pedagogical tools was that such tools were not “available and supported in the classrooms in which I typically teach.” Respondents to the open-ended section of the survey elaborated on their frustration with NC State’s classroom infrastructure. “This particular classroom,” said one respondent, “[had] no technology other than chalkboard, eraser, and chalk. As a strongly technology-oriented instructor, the lack of technology severely limited my ability to lead this class. This was a great disappointment to me, and I believe that students missed out as well.”

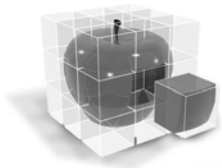
“I would use in-class technology a lot more,” said another, “if the classrooms at NC State had better capabilities. ... Our rooms are just not set up for the digital age, and until they are, digital teaching will be just an inconvenience, as it is every time I have to lug my laptop and LCD projector with me and spend 15 precious minutes setting it all up. We need a major investment in wired classrooms, with good equipment.”

Time and incentive to innovate

Almost as many respondents (36 percent) said that they would use technology-assisted pedagogical tools more often “if I had more time to develop assignments or classes with these technologies.” As one respondent stated frankly, “There are a number of technologies that would enhance my course, but without support, time, and recognition, I’ll have trouble investing the time, especially in light of the other work I do for the department and in light of the fact that I’m coming up for tenure.” Another respondent corroborated this view: “Learning

technology is time-consuming and my department head has no means of evaluating or rewarding me for this extra effort.”

Some respondents took care to add an important caveat: Teaching innovations must lead to enhanced learning outcomes: “Structuring rewards so that innovations are noted would help, but care must be taken to reward those who achieve higher teaching effectiveness with it rather than those who just produce really good shows.”



CHAPTER 4

Special Topics

In the course of their investigations, the LITRE research groups identified several critical gaps in NC State's technology-rich learning environment. They investigated these areas as special topics, developing them into potential action initiatives during summer 2003. Some of these were adopted as first-wave action initiatives. The ongoing LITRE effort will advocate for the implementation of others as funds become available.

Critical needs

Classroom improvement

NC State currently has 247 "110-designated" classrooms, with an additional 50 scheduled to be built or renovated by 2010. The university follows the North Carolina State Commission on Higher Education Facilities definition of a "110-designated" classroom: "A room used for scheduled instruction that requires no special, restrictive equipment or configuration. It includes general-purpose classrooms, lecture halls, recitation rooms, seminar rooms and other rooms used primarily for scheduled non-laboratory instruction."

Although individual departments and colleges have already outfitted approximately 85 of these general-purpose classrooms with some level of multimedia capabilities beyond the standard overhead projector and screen, these upgrades are scattered, and there is no continuing stream of funds to maintain them. Computer-ready classrooms are a rarity. As Dennis Daley, chair of the faculty, points out, NC State's classroom deficiencies have a direct effect on faculty's willingness to experiment with technology-enhanced teaching. If NC State's faculty are unlikely to be assigned to a classroom appropriately equipped to use technology-enhanced course materials, they will not invest time and energy in improving their courses in this way.

NC State has begun to take steps to address the technology deficiencies of its classrooms. In fall 2002 the division of Facilities Planning and Design, in conjunction with many other campus units, completed new design standards for classroom technology. The newly approved classroom standards mandate that any new or renovated classroom have multimedia capabilities, allowing instructors to deliver course content using a network connected-computer, projection system, visual presenter, recorded audio or video sources. Depending on how the classroom is outfitted, upgrading a single classroom to accommodate multimedia instruction can cost between \$20,000 and \$75,000. Outfitting a classroom for distance education can cost more than \$200,000. This is a substantial investment of new funds, and NC State must develop an organized system to schedule multimedia classroom installations, allocate funding, maintain installed equipment, and train users.

Meanwhile, NC State's existing classrooms need immediate attention. NC State's program for repairs and renovations to existing buildings is funded by the North Carolina General Assembly and is allocated to the university through a formula used for all public buildings in the state. Because of state revenue shortfalls in recent years, the legislature has not consistently funded the R&R program. However, in the 2003 legislative session, the legislature approved \$300 million in borrowing for R&R for all state agencies. NC State has requested that \$600,000 of this fund be allocated to classroom projects. Because of the importance of classrooms, NC State has also established a recurring allocation from the operating budget designated specifically for classroom improvements. This allocation is in addition to the state's renovation and repair appropriations.

To identify immediate classroom needs, each year the Facilities, Planning, and Design staff solicits classroom-improvement requests from deans, directors, and department heads. After estimating the costs of these projects, FP&D submits them for consideration and prioritization to the Classroom Environment Committee, a broadly representative team chaired by a faculty member. In 2001-02, the CEC had a total allocation of

approximately \$350,000. By 2003-04, because of state revenue shortfalls and resulting budget cuts, this allocation had been reduced to just over \$254,000, a 37 percent reduction in two years. While the annual requests for repairs and improvements submitted by deans, directors, and department heads have always far outstripped available resources, this significant reduction makes maintenance and improvement of existing classrooms even more difficult.

Furthermore, the shortfall in the budget for repairs and maintenance is expected to get worse over time. While the Phase I bond projects cover the infrastructure and initial equipment purchase of fifty new technology-enhanced classrooms that are being built (over \$13 million), neither the bond nor the state's funding formula for building maintenance, repairs, and renovations covers the needed maintenance and ongoing support for instructional technology equipment in those classrooms. The time to plan to maintain and support this considerable investment in NC State's learning environment is now.

To begin to address these needs, in early spring 2003 the Classroom Environment Committee recommended a pilot project to help NC State get started bringing its classrooms up to the new standards. Then-interim provost Robert Barnhardt approved this pilot project, allocating \$196,000 for FY 2003, plus additional funding for installation in FY 2004, and money for maintenance in subsequent years. The pilot project is known as ClassTech.

ClassTech will bring twelve classrooms on Main Campus up to the new technology standards established in 2002. The selected classrooms represent a variety of room capacities in a variety of buildings that are heavily used by a variety of different departments. The project includes not only technology equipment but also funding for maintenance and support. The equipment required was purchased and installed during 2003, and the upgraded classrooms will be ready to use in spring 2004.

Faculty computing

NC State does not have a regular system to provide faculty with computers that parallels the schedule for labs and classrooms. Many faculty at NC State work on remaindered equipment from surplus or computers they buy themselves. There are few staff explicitly assigned to support faculty machines and software.

Not having access to the same software, tools, and level of support as their students distances faculty from instructional computing and makes it difficult for them to participate in the initiatives the university wishes to launch in this area.

If faculty have access to the same platform and software as their students, they can:

- ensure that course materials and tools work on the student platform;
- troubleshoot problems with applications, tools, and content;
- exchange materials with students more efficiently;
- devote more time to teaching and incorporating new technologies;
- build continuity between courses, thus improving long-range instructional planning.

There is anecdotal evidence that many faculty at NC State are technology poor in our technology-rich environment. To gauge the depth and severity of this problem, NC State should conduct an inventory of computers used by faculty for instruction and should use the results to formulate a funding strategy to provide faculty with appropriate computing resources.

File space quotas

To take advantage of the vast computing resources that have been amassed for their use during a decade of development, students and faculty must have access to ample file space. At NC State, AFS quotas have remained frozen at 50 MB since 1999. IMAP mail quotas were recently raised to 30 MB, but remain too small to handle the 15 attachment limit now permitted. Currently, students and faculty do not have access to enough space to execute programs, store large files, send/receive mail attachments, or archive valuable data objects and digital assets.

Comparisons with other institutions show that NC State is far behind in this resource.

NC State

- AFS space: 50 MB; additional quota available for a fee
- IMAP quota: 30 MB; additional quota available for a fee

UNC-Chapel Hill

- AFS space: undergraduates - 100MB; graduate students, faculty, staff - 250 MB
- IMAP quota: No quota enforced.

Notre Dame

- AFS space: Freshmen - 50MB; all other students - 200 MB; faculty and staff 500 MB
- IMAP quota: 50 MB

University of Michigan

- AFS space: 200 MB
- IMAP quota: 250 MB

MIT

- AFS space: 200 MB default; up to 600 MB upon request (with justification)
- IMAP quota: 100 MB

File space should be allocated on request without charge (up to a soundly reasoned quota with purchase options available for higher levels), or the campus needs to maintain an across-the-board program of regular increases to keep pace with technology changes and user needs.

Software licensing

At NC State, software licensing for major products is coordinated by the Information Technology Division's Computing Services unit. For example, for the Symantec (Norton) Anti-Virus software, ITD negotiated a university-wide license with coverage for both university-owned and personally owned faculty, staff, and student computers. The cost is approximately \$50,000 per year. Because of ITD's experience in negotiating these contracts and its collaboration with other campuses, the UNC Office of the President requested that NC State partner with that office to lead the negotiations for all sixteen campuses. The high volume of licenses involved resulted in a much better contract than a single university could have negotiated.

Not all licenses are acquired centrally. NC State's colleges, departments, and units also acquire and license software according to their specific needs. When funding for software is distributed through the colleges and departments, pulling the funding resources back together to realize economies of scale is a major challenge. A recent example is the AutoCAD software. In 2002 ITD negotiated a license with AutoDesk for the unlimited use of almost all of their products for \$25,000. To make this happen, ITD partnered with all the units that were using AutoCAD to put together the required funding. Effecting this collaboration was difficult, but it reduced the cost to the campus by 75 percent (or about \$75,000), and allowed many units to have AutoCAD applications that could not previously afford them.

To facilitate such negotiations, in fall 2002 the University Information Technology Committee formed a Software Subcommittee, including representatives from most colleges, with the director of Computing Services as chair. The goals of the subcommittee are to develop a process for identifying and prioritizing products for centralized license negotiation and acquisition (with the attendant cost savings) and to ensure that software is consistently and appropriately maintained and updated in the server environment and in the multiple campus labs. The subcommittee plans to build a business case for proposing that an additional ten to fifteen of the most critical and expensive software licenses be funded from a central resource. Licenses to be considered for central funding include Novell, MATLAB, Maple, and SAS.

To expedite the flow of information, the subcommittee has undertaken a software inventory, which has unfortunately been slowed by staff time limitations. Several additional components are planned for the inventory site, such as a password-protected page with privileged information for support consultants.

Another promising area is the use of utilities like Keyserver and FlexLM to manage concurrent use of licensed software on desktop machines all over campus. These utilities allow access to the software applications if licenses are available. The advantage is that NC State can license expensive pieces of software such as Adobe PhotoShop or Macromedia DreamWeaver in a limited way for occasional use. The Software Subcommittee estimates that such products could allow us to reduce the number of licenses (and hence the cost) for some applications while maintaining critical access.

Learning management systems

Learning management systems can make instruction more flexible, accessible, and effective. Selecting an appropriate LMS is crucial to accommodating the various learning styles and teaching methods that uniquely characterize the various disciplines. Currently, the learning management systems in use at NC State are WebCT Campus Edition and a university-developed course management system known as WolfWare. Some faculty choose to develop on-line courses outside of either system.

The unit responsible for licensing and supporting learning management software used at NC State is the Learning Technology Service. During spring 2003, LTS conducted an evaluation process involving faculty and students. On the basis of that evaluation, LTS determined that it will continue to develop WolfWare, work to purchase the new WebCT Vista product on or before July 1, 2004, work toward a launch of WebCT Vista by Summer 2005, and work toward seamless integration of WebCT Campus Edition, Vista and new versions of WolfWare. LTS staff believe that the content management functionality of WebCT Vista will reduce overhead associated with LMS course administration and promote collaboration among faculty, programs, departments, and colleges.

Meanwhile, LTS will continue to assess both NC State's needs for LMS products and the various commercial and open-source LMS products available, including:

- WebCT Vista - Enterprise-scale commercial LMS software package;
- Centra Symposium - Suite of real-time collaboration software components;
- WolfWare - Internally developed storage management toolset;
- WebAssign - Quizzing and assignment software appropriate for math, science, and technical courses;
- Integration - Framework for combining all components into a ubiquitous student experience.

The LITRE project will take an active interest in NC State's transition to a new learning management system, ensuring that the LMS we choose is effective at the institutional level. An effective system must enable active, self-paced learning; provide flexible and efficient access to instruction; accommodate different learning styles; and provide continuous assessment of student progress. The LMS infrastructure should allow for access and interoperability between both credit and noncredit instructional programs.

Digital asset management

Although many individuals and units at NC State are hard at work creating and collecting images and multimedia resources in both analog and digital formats, NC State currently has no overarching scheme for ensuring that they will be accessible in the future. Each college can list its own examples of significant digital media collections and of faculty, staff, and students who are generating materials and saving them (temporarily, at least) in a variety of locations ranging from personal computers to college or departmental servers to Unity file space. Each unit must make complex decisions regarding metadata formats and standards for describing its content, the use of controlled vocabularies for classification and access, the characteristics of search and display interfaces, and myriad other attributes of the systems, which in the end are typically not interoperable with others on campus.

NC State students and faculty could benefit from a scaleable, university-wide system for digital asset management, or, at a minimum, a common set of standards and access mechanisms. Collection "units" might range from individual learning objects to course modules or even entire on-line courses.

Ready access to a well-indexed collection of digital materials is of obvious value for research and study. A well-chosen digital asset management system can provide the database infrastructure and techniques that allow new content to be easily cataloged, indexed, and archived into the system, and content within the system to be easily identified and retrieved by authorized users.

Furthermore, digital asset management is a growing trend among large organizations. Efforts to establish such systems are ongoing at institutions including Cornell University, the University of Michigan, the University of Texas at Austin, the University of Wisconsin, and Penn State.

The LITRE team recommends that NC State consider establishing a collaborative group of stakeholders from interested colleges/departments and units, the Libraries, the Information Technology Division, and DELTA to investigate digital asset management system needs, existing systems on campus, available products/solutions, support, and costs. This group should prepare a report for the provost that includes specific recommendations and a business model analysis.

Student electronic portfolios

One application of a digital asset management system is the emerging use of student electronic portfolios. The e-portfolio is a collection of work that students build over the course of their academic careers, demonstrating the development of knowledge and skills. The use of e-portfolios should be approached thoughtfully and integrated into the curriculum so that students and faculty have appropriate expectations. For example, in some programs, the emphasis might be on outcomes assessment, while in others, the e-portfolio might be primarily for the student's own use or presentation to potential employers. The National Learning Infrastructure Initiative, a program of EDUCAUSE, has declared e-portfolios to be a "key theme because their use has the potential to transform teaching and learning so that it is more learner-centered and outcomes-oriented." NLII has identified a set of "research and analysis questions" that will be very useful for institutions considering e-portfolios. Penn State University offers an example in production with its Online Student Portfolio Program.

At NC State, a few curricula have already begun to require student e-portfolios or their precursors at the course level, such as the College of Education and the College of Natural Resources. However, there is currently no university-wide documentation, guidelines, infrastructure, or organized support for these efforts, and such coordination and development should be considered.

Technology support for students

Technology is an effective learning tool only when it is in the hands of skilled users. When a student is unskilled in technology applications, technology can constitute a barrier to learning, frustrating the student and usurping learning time from the subject or discipline. Students who are incapable of negotiating WebAssign, WolfWare, WebCT, spreadsheets, on-line databases, Websites, e-mail, word processing, and multimedia programs are closed off from important learning tools in NC State's technology-rich environment.

NC State's student surveys consistently show a need for enhanced access to trained staff for help, and access to technology training classes. Such services constitute a safety net for students who are experiencing technology as an obstacle rather than a bridge to learning. This safety net could be a mix of existing and new support services available to campus-based and distance education students.

One way of proceeding is to enhance the support resources NC State already has. For example, we could provide additional training in computer applications to NC State's tutors and supplemental instructors. Tutors with this special training could serve an additional function as special computing consultants to provide just-in-time support for students having difficulty with software functions and tasks related to networked communication.

To pinpoint the specific shape or components that would make up this safety net, however, NC State needs to conduct more in-depth needs analysis. While such an analysis will most likely include things for which need has already been expressed, such as extended help desk support hours, it also might include components like remedial training services or technology support by student mentors. We can base this analysis on assessment tools we already have in place, including the new Undergraduate Academic Program Review and a refinement of annual surveys.

Some safety-net services might be offered university-wide, but others should be based in the colleges or departments so that they can be discipline specific. All of these services should be well marketed to students—particularly those who may have been identified on the information and technology skills and knowledge assessment as needing help. Faculty, librarians, advisers and others would also be encouraged to make referrals.

Support services should not target only those at low levels of proficiency. Many NC State students have reached extraordinary levels of technology skill. We must provide a sustainable supportive environment for high achievers to excel and create new and innovative uses of technology. This environment can come through resources students have within their disciplines, but also by the campuswide academic computing environment.

Faculty innovation grants

To enhance the technology-rich learning environment, NC State must support faculty in their efforts to explore the use of instructional technology as a pedagogical tool. NC State has a successful model for offering this kind of assistance in its DELTA IDEA Grants program, which provides funds and personnel to NC State faculty and staff to support innovation in the use of instructional technology in distance education. From 2000, the

first year grants were offered, to 2002, 102 recipients were awarded IDEA Grants totaling almost \$1.5 million. Sixteen recipients received awards totaling \$118,753 in 2003.

Although the IDEA Grants program has been very successful, the restriction of the grants to distance education is not appropriate to the direction that on-line education is taking at NC State and across the nation. Programs no longer break neatly into categories like “distance education” (space and time independent) and “classroom education” (space and time dependent). Instead, the trend is toward incorporation of successful on-line learning pedagogies wherever they are appropriate.

To maximize innovation across our learning environment, NC State should establish grants programs to support all faculty who wish to experiment with instructional technology, regardless of whether their teaching is in the classroom or on-line. Such support will enrich all types of campus instruction. Results of the 2003 LITRE Faculty Survey indicate that faculty who innovate in distance education courses are more likely to incorporate successful techniques into their classroom-based instruction. Similarly, faculty who develop Web materials to supplement traditional classes often find that they have built a sufficient library to offer a stand-alone Web-based course.

Information exchange

The changes—both positive and negative—that accompany the permeation of new technologies in teaching and learning are subject to the rigorous examination and discussion appropriate to any academic field of inquiry. The successful integration of new technologies in teaching and learning will depend on the promotion of discussion among faculty, the circulation of information about diverse aspects of technological adoption, shared knowledge about teaching strategies, results of assessment studies, and many other topics.

Effective communication is one of the fundamental challenges of a university as large and diverse as NC State. New communication technologies have a remarkable reach, but information overload can mean that intended recipients do not read all messages of import. In addition, it is often difficult for people to know where and how to find the information they need, or to be kept apprised of discussions and presentations of value.

In light of these challenges, the LITRE effort needs to stress the importance of discovering more effective ways to engage the stakeholders in teaching, learning, and technology. A promising development in this area is the success of the Teaching, Learning, and Technology Roundtable, an open and voluntary advisory council that engages a wide range of topics for discussion among faculty, technical staff, administrators, and students. Another significant forum is the Council on Undergraduate Education. When discipline-specific discussion is appropriate, technology task forces on the department or college level can be useful. The Faculty Center for Teaching and Learning, with adequate staffing, could serve as the appropriate clearinghouse for information and opportunities related to teaching, learning, and technology.

Emerging technologies

Accessibility and universal design for learning

In part as a result of federal law, it is now standard practice to incorporate accessibility into the design of many technological products and services. Some faculty at NC State have discovered that using the principles of accessibility and universal design diversifies and enhances their on-line and digital course materials. The NCSU Libraries have been incorporating accessibility considerations into digital resources since the 1990s. Generally speaking, however, the learning needs of students with disabilities at NC State are generally accommodated with a reactive retrofit “as needed” model. In terms of Web and other digital learning content, this model costs more and provides learning benefits for fewer students. Greater education, collaboration, and coordination is needed if the university is to reap the full benefits of an accessible learning technology environment.

Wireless data connectivity and mobile computing/communications systems

Secure wireless access to NC State’s data network is not currently available everywhere at NC State. Although Communication Technologies has a complete “student first” wireless data network plan in place, implementation awaits funding.

To support this network, NC State will need to develop a coherent wireless and mobile computing environment—including systems, software, and training for faculty. ITD and LTS have proposed an integrated plan for a new layer of strategic mobile services. These services include applications to streamline creation of

content for mobile devices, simple ways to deliver that content, and training for faculty in the potential uses of mobile computing devices to enhance learning.

Meanwhile, technology marches on. Wireless communications and computing technologies have already converged. Most NC State students come to campus equipped with personal cell phones, and they are facile with multiple modes of wireless communication, including voice, e-mail, and instant messaging.

Pilot projects and specific programs at NC State are already experimenting with the use of wireless handheld computers and personal digital assistants to create opportunities for interactive and real-world learning. Examples include the College of Agriculture and Life Sciences' handheld computer project and the College of Veterinary Medicine's Mobile Computing Initiative. On the horizon are mobile collaborative environments made possible by converging communications and computing technologies.

Advanced remote access services

As students expect “anytime/anywhere” access to computing resources, the old dial-up access service NC State offers does not meet even current needs. NC State should explore the possibility of using the new blade computers and other grid-related technologies to offer easy-to-use, cost-effective remote access to the complex and expensive specialized software applications students need for success in their disciplines. This technology enables students to log into virtual workstations from their homes so that they can use software without downloading it to their computers and without paying for a software license.

ITD has proposed to develop and field test a set of grid-based, specialized, remote-access services that will expand and enhance the technology environment available to NC State students on and off campus.

Policy barriers

NC State is impeded in its quest to nurture its innovative learning environment by several structural, political, and policy barriers. Although NC State has no immediate control over some of these barriers, all such issues should be reexamined in the light of the LITRE vision.

Copyright policy

NC State's copyright policy is vital to creating a climate that encourages NC State faculty, staff, and students to apply their best efforts to the innovative use of technology in learning and teaching.

Both the UNC system and NC State have copyright policies that include sections addressing the creation of digital scholarly works. The Copyright Use and Ownership Policy of the University of North Carolina was instituted in May 2001 in response to a report of the UNC Faculty Assembly. The NC State Administrative Regulation for Copyright Implementation Pursuant to Copyright Use and Ownership Policy of the University of North Carolina followed in August 2001. The NC State Administrative Regulation added to and refined the UNC policy by identifying administrative procedures by which NC State would implement the UNC policy.

Four major campus groups are currently addressing copyright issues for digital scholarly works. These are 1) the University Standing Committee on Copyrights, 2) the Faculty Senate, 3) the University Office of Legal Affairs, and 4) the NCSU Libraries' Scholarly Communication Center.

Some faculty regard the Copyright Use and Ownership Policy at NC State as a barrier and disincentive to innovative work in teaching and learning with technology—particularly its provisions on “exceptional use” (“university funding or gifts specifically in support of the work's creation”). Faculty point out that “exceptional use” could include accepting assistance in course development, whether technical or pedagogical, and that almost any university activity involves “use of university personnel (e.g., secretaries or other support staff, research assistants, work-study students).” Knowing that accepting resources defined as “exceptional” mandates that they will have to negotiate whether they retain their traditional copyright with the university, some faculty have declined to make full use of the support resources that NC State offers. Thus, the policy has had the perverse effect of impeding innovation.

In addition, NC State has no clear process for third parties to request and receive permission to use university-owned works, or to support NC State faculty who seek permission to use material protected by external copyright. Such processes must be both timely and reasonable. Designing them requires a deep understanding

of educational materials and how they are compiled and used, and will be most successful in the context of collaborative relationships with faculty.

Finally, NC State must find ways to comply with the recently enacted TEACH Act, which “updates copyright law pertaining to transmissions of performances and displays of copyrighted materials. Such transmissions are critical to current higher education distance education efforts, including on-line courses.” The TEACH Act imposes a requirement for “downstream controls,” technological measures that reasonably prevent retention of works in accessible form or unauthorized further dissemination in accessible form. In order to produce on-line course materials that are TEACH-compliant, the university must identify appropriate downstream-control technology and make the related support and guidelines available to faculty and students. The Office of Legal Affairs, the NCSU Libraries, DELTA, and the Information Technology Division have formed a partnership to develop and test a downstream-control mechanism.

The LITRE team supports the university’s ongoing review of copyright policy and procedures. Proposed changes in NC State’s administrative structures, policies, and business practices should align our institutional practices with the needs of faculty and students. The revised rules should address the copyright environment beginning when creative ideas take shape and extending through their embodiment in intellectual works, and should address the use, sharing, and reuse of those works in the classroom and in research. The revised rules must address both externally produced content and the allocation and management of ownership rights for works created by university employees and students, all in light of current law.

Distance education course policies for resident students

In 1998 the University of North Carolina implemented a new enrollment funding model that provides equivalent funding for university instruction regardless of whether it is delivered in campus-based classes or by distance education. Implementation of this new model brought distance education into the academic mainstream, and since 1998 enrollment in NC State’s distance education programs and courses has grown 15 to 20 percent annually.

Many students enrolled in campus-based degree programs choose to earn some credits toward their degrees in distance education courses. The availability of distance education increases course options and alleviates the shortage of seats in traditional classroom sections. Students who enroll in a distance education course can make progress toward their degrees even if they are not physically present in Raleigh during the summer or during a co-op semester.

Despite the recent successes of distance education at NC State, the full blending of distance education into campus-based degree programs has been inhibited by significant policy, financial, and perceptual barriers. These include tuition and fee inequities between DE and campus-based courses, different treatment of DE courses in NC State’s policies regulating suspension, and insufficient resources to support DE instruction for resident students.

At NC State, there is one rate structure for “regular term” (on-campus) courses and a separate structure for “distance education” courses. The two structures are not coordinated.

1. A student enrolled in both on-campus courses and distance education courses has two separate charges for tuition and fees (though the two now appear on one aggregate billing statement).
2. A student who is already paying full-time regular-term tuition would not have to pay extra tuition for an on-campus course, but does have to pay extra tuition for a DE course.
3. A student taking both an on-campus course and a distance education course must pay some fees twice.

The prospect of paying fees twice or paying extra tuition for a DE course keeps many cost-conscious full-time students from taking DE classes, and is a significant barrier to full incorporation of DE classes into the academic mainstream.

A second barrier is NC State’s readmission policy for academically suspended students. Academically suspended students have only three options to return to good academic standing: summer school, independent study, and distance education. The result is that many academically suspended students choose to take DE courses, and the students enrolled in DE courses are disproportionately “at risk.” Unfortunately, DE is often a bad pedagogical choice for students on academic suspension. DE demands extraordinary self-discipline and time management—skills that at-risk students often lack. In fact, their weakness in such areas is often the reason they got into academic difficulty in the first place.

A third barrier is the lack of funding for course development, production, distribution, and faculty and student support services for DE instruction taken by resident students. State-appropriated resources for distance education and regular-term instruction are calculated differently. Distance education uses DE tuition rates times student credit hours, and regular term uses a full-time tuition rate times an FTE student count. In the past, state allocations for distance education and regular-term instruction came to the campus within different funding categories. In 2002 these categories were combined, but the state still requires that expenditures for DE and regular-term instruction be accounted for separately.

Technology-based instruction requires more course development, production, distribution, and faculty and student support services than are typical for on-campus instruction. For DE instruction, some of these services are provided by DELTA, which retains a portion of the state formula funding for DE enrollments. No such allocation exists for support of technology-based, DE instruction for resident students.

The most appropriate mechanism for providing the requisite resources is an enrollment-formula-based model for DE instruction to resident students that is similar to the model for straight DE instruction. The model would require that the current enrollment planning process be extended to project resident-student enrollments in DE courses. This would be an internal projection that would not change the current procedures for reporting enrollment projections to the Office of the President. Such an institutional change in the policies for DE instruction to resident students would, however, change resident-student enrollment patterns and would thus require a review and revision of NC State's ten-year enrollment plan.

The LITRE team recommends that the university change its DE course policies for resident students. Removing policy, financial, and perceptual barriers to the full blending of distance education into campus-based degree programs will help the university optimize the use of classroom facilities and will reduce the pressure on NC State's physical infrastructure. DE courses give students increased flexibility and more year-round learning opportunities. Incorporating DE into the academic mainstream may improve students' time-to-degree completion, a significant indicator of institutional effectiveness.

The General Education Requirement on technology literacy

The intent of general education requirements is to ensure that undergraduate students acquire the basic skills and context to engage fully in undergraduate education. The standing faculty committee that advises on the GERs at NC State is the Council on Undergraduate Education. During the 2002-03 academic year, CUE substantially revised the GERs, rewriting rationale statements and learning objectives for all categories except for Information and Computer Literacy. CUE deliberately delayed rewriting this requirement until LITRE had completed its preliminary research on student fluency.

CUE recognizes that the current Information and Computer Literacy GER is out of date and overly simple for today's technological environment. The Information and Computer Literacy category used to be divided into two subcategories, Computer Literacy and Library/Information Literacy. CUE has already moved the Library/Information Literacy component into an expanded Writing, Speaking, and Information Literacy category. During 2003-04, a CUE subcommittee will develop the rationale and learning objectives for Computer Literacy, which may be renamed Technology Literacy.

The current Computer Literacy GER focuses on basic productivity applications. By definition, virtually any computer-based instruction or assignment would fulfill the requirement.

NC State's current Computer Literacy GER (in place since 1994)

Rationale: Today's graduate must have a knowledge of information technology and computer applications. Every student needs a basic understanding of information processing. It is not necessary that every student be a programmer.

Students should develop and demonstrate proficiency in the use of computers, learning to use applications such as word processing, spreadsheets, database management programs, electronic mail, and packages and applications specific to their field of study.

Requirement (integral curriculum content): The following may be used to fulfill computer literacy instruction:

- instruction and assignments required within courses, and/or
- required use of a computer to complete assignments.

In practice, each college determines how the Computer Literacy GER is met for its programs. Some colleges require students to fulfill the requirement by completing a course focused specifically on computing skills.

Other colleges integrate technology-skill training into an overview course. The result is that some students are better equipped to interact with a technology-rich environment than others, and that many students find that they are more comfortable interacting with the technology environment within their disciplines than with the technology environment as a whole.

The LITRE vision statement acknowledges that technology is an effective learning tool only when it is in the hands of skilled users. An effective technology GER is an integral element in ensuring a skilled user base. The LITRE team recommends that CUE broaden and redefine the Technology Literacy GER to go beyond basic productivity applications to include critical thinking skills and fluency in information technology in the broader context of a university education.

Reappointment, promotion, and tenure

NC State's current reappointment, promotion, and tenure procedures recognize six areas of excellence in creative scholarship. Scholarly contributions in an appropriate mix of these realms are the principal criteria for decisions about faculty reappointment, promotion, and tenure.

One of the six areas of excellence is Teaching and Mentoring of Undergraduate and Graduate Students: "Transmission of knowledge to students and the development of wisdom are the *raison d'être* of universities. Knowledge, insights and understanding are transmitted through disciplinary, interdisciplinary, and multidisciplinary learning. In all cases, the goal is to develop individuals who will live meaningful lives by playing very effective and socially constructive roles in various human institutions."

The actual recognition of teaching and mentoring in RPT decisions at NC State is uncertain, however—particularly for faculty who identify teaching and mentoring as their major area of excellence, and particularly for faculty innovators who experiment with cutting-edge techniques like teaching with technology.

One obstacle to the appropriate recognition of teaching excellence is that teaching is difficult to evaluate. Although NC State recognizes general standards of scholarly performance (i.e., clear goals, adequate preparation, appropriate methods, significant results, effective presentation, reflective critique), many departments need help translating these general standards of scholarship to the domain of teaching. Furthermore, the general standards provide no criteria for evaluating specific teaching skills, including clarity, adequacy, appropriateness, significance, and effectiveness.

Another obstacle is uncertainty over standards for the scholarship of teaching and learning (SOTL). Although there are many means of rigorous external peer review of the scholarship of teaching and learning (e.g., MERLOT, external review of course portfolios, peer-reviewed journals devoted to teaching), faculty and department heads are not always comfortable assessing the merits of teaching-based research, particularly when the problems and methodologies are substantially different from the problems and methodologies of traditional scholarship in their disciplines.

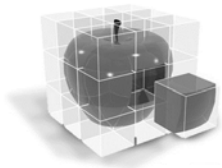
Furthermore, confining the definition of SOTL to publication in peer-reviewed journals may be too restrictive. The scholarship of teaching and learning includes disparate activities: the adoption of instructional practices informed by contemporary research on learning; the use of assessment as a way to improve instruction; and various ways of making teaching practices public (e.g., peer observation, open discussion, publication). All of these activities should be recognized as valid demonstrations of excellence in teaching.

Similarly, there currently exist no appropriate quantitative measures to establish the quality of contributions in academic technology. Scholarship in the academic technology area includes the development and evaluation of computer hardware and software to enhance learning, expansion of delivery mechanisms to facilitate learning in multiple modes (visual, auditory, tactile, etc.), and innovations in the use of technology to both develop and assess knowledge (e.g., wireless feedback systems, PDA applications, 3D projection systems, etc.). Current RPT criteria are not structured to recognize significant contributions to this type of learning research.

The LITRE team recommends that an accepted review process be established to evaluate the quality of academic technology accomplishments and to quantify the creator's contribution to technology-enhanced learning.

Specifically, the LITRE team recommends that the university

1. Establish clear guidelines for demonstrating excellence in teaching and learning with technology.
2. Revise reappointment, promotion, and tenure standards to recognize teaching and learning with technology as an area of excellence in RPT decisions.
3. Expect that the provost, deans and department heads will communicate and support these guidelines.



CHAPTER 5

LITRE Organization

Acquiring and building a technology-rich environment involves significant expenditures of time, effort, and resources. To justify such expenditures, NC State needs good evidence that we are using instructional technology appropriately and effectively to enhance student learning. Accordingly, the LITRE team determined that the appropriate way to structure the ongoing LITRE program was as an ongoing empirical inquiry charged with amassing evidence about which aspects of a technology-rich environment are most effective in improving student learning. The LITRE program will be an investigative process through which new approaches to student learning, enhanced with educational technology, are proposed, vetted, empirically evaluated, and if the evaluation results so indicate, deployed in other units as appropriate. NC State will use the information gleaned from this inquiry to inform future LITRE recommendations and project selections.

The LITRE team envisions the launch of a variety of research strategies, such as:

- a retrospective look at the impact of existing and/or past technology initiatives on student learning and faculty engagement;
- collecting data on faculty and student use patterns and satisfaction with the educational-technology applications, resources, digital content, and infrastructure;
- experimenting with new uses of technology;
- monitoring the impact of key investments to which NC State is already committed or to which it may commit through the compact-planning process;
- developing a literature review or review of best practices on other campuses, including our university peers.

Many of the projects discussed in chapter 1, such as Project 25, the Engineering Pilot Laptop Program, the Mobile Computing Initiative, LOBO, and SCALE-UP, include formal assessment of their impact on student learning. An important task for the ongoing LITRE program will be the compilation of results from these assessments, as well as those from formal LITRE initiatives and other ongoing technology-related projects, into a continuously updated overview of the impact of NC State's technological initiatives.

Another source of data is survey results. Periodic administration of the LITRE Faculty Survey and technology-specific questions in the university's annual Graduating Senior Survey and biannual Sophomore Survey will provide ongoing information relevant to many LITRE activities. Existing questions about the LITRE-related issues and about the technologies faculty use and students encounter will continue to be asked, and new questions about specific LITRE projects will be added as appropriate. University Planning and Analysis is responsible for the Graduating Senior Survey and Sophomore Survey and for administering the Faculty Survey, and will work with LITRE to analyze and interpret the results.

Leadership

Any research effort needs a principal investigator. The tasks of the LITRE organization include innovating, researching, applying research results, communicating with faculty, disseminating information, and advocating an academic perspective. Accordingly, the ongoing LITRE program will be led by a faculty member who has strong experience with teaching with technology and the research skills needed to oversee the university's ongoing inquiry into the effects of technology on student learning. This faculty member will be released from most teaching and research responsibilities while serving as head of LITRE.

Leadership by a teaching faculty member will help ensure that LITRE remains a faculty-driven movement. In the past, institutionalizing faculty-initiated innovation as an administratively driven activity has reduced faculty interest.

In addition to leading the empirical inquiry, a major responsibility of the LITRE head will be to play an advocacy role for learning in a technology-rich environment. The immediate goals of this advocacy are:

- to bring a faculty-based, reflective perspective to the university's strategic planning and policy making related to technology and student learning;
- to encourage action on critical needs identified by LITRE's preliminary research;
- to help coordinate the variety of frequently unconnected projects sharing the common objective of improving learning with technology;
- to facilitate communication, partnerships, and resource leveraging among various faculty, departments, colleges, and divisions, so that improvements spread throughout the university.

The head of LITRE will report to and advise the provost. The LITRE head will serve alongside the vice provosts, which will give him/her frequent opportunities to bring a focused perspective to matters related to teaching, learning, and technology during compact planning and policy discussions.

The LITRE head will be housed in DELTA and receive day-to-day support there. The head will be supported with staff sufficient to coordinate and support the work of the LITRE committees and to administer the grants program.

LITRE Advisory Board

The LITRE head will be assisted by a LITRE Advisory Board including faculty (a majority of board members), the dean of the graduate school, the vice provost for undergraduate affairs, and representatives of key support units such as DELTA, the Faculty Center for Teaching and Learning, ITD, and NCSU Libraries. The LITRE Advisory Board will be charged to:

- inform the provost, deans, vice provosts, and faculty about TLT initiatives across campus;
- identify and actively support TLT initiatives with great strategic importance to the university;
- assist the head in administering the LITRE Grants program;
- encourage rigorous assessment of student learning resulting from TLT initiatives and provide assistance as needed;
- integrate and disseminate the results of evaluations;
- recommend to the provost policies and planning and resource priorities that would promote learning in a technology-rich environment.

LITRE Assessment Committee

The LITRE Advisory Board will institute a LITRE Assessment Committee including the LITRE head, active TLT principal investigators, and assessment professionals from across campus (e.g., from the colleges, DELTA, the Faculty Center for Teaching and Learning, University Planning and Analysis, the Division of Undergraduate Affairs, and the Graduate School). The LITRE Assessment Committee will be charged to:

- advise and assist faculty with assessment of teaching and learning with technology initiatives as needed;
- develop an annual overview of teaching and learning with technology assessment results across campus, identifying successes, challenges, and issues to inform planning and policy decisions for the university.

Assessment

To assist LITRE's project investigators in amassing the kind of empirical data LITRE needs, LITRE will offer guidelines for assessing projects initiated or supported by LITRE, and, insofar as is practicable, projects that are initiated or supported in other ways.

Assessment should be appropriate to a project's goals and scope. Specific assessment strategies will thus vary from project to project, but the assessment of every LITRE project should address whether the project contributes to student learning.

Faculty often assume that assessment involves something extra, typically added at the end of instruction and performed by an outside expert conversant with sophisticated statistical techniques. But there has been a shift over the past fifteen years to the use of smaller-scale, classroom-based assessment conducted by faculty using classroom assignments and feedback from colleagues and students. This kind of assessment is simply part of faculty's teaching, a continuous effort to determine the impact of teaching on student learning, rather than an add-on to satisfy an external reporting requirement.

Faculty may need guidance on how to conduct classroom-based assessment of this type. The LITRE head and staff will assist faculty in assessing the effectiveness of technology in improving student learning. In this effort, LITRE will draw on, coordinate, and review resources from several units on campus, including the Division of Undergraduate Affairs, the Campus Writing and Speaking Program, the Faculty Center for Teaching and Learning, and DELTA.

In addition to assessing whether a given LITRE project contributes to student learning, LITRE will also want to determine whether the project can be expected to have long-term effects that are not manifest immediately, whether it alters the way participants view education, and whether it uses project and university resources efficiently. For example, the assessment of a project on wireless collaboration between students in a course might include research on the students' problem-solving behavior, on how faculty's experience with this approach affects their pedagogy in other courses, and on how groups collaborating this way use laboratory resources. Assessment of this sort is both a contribution to scholarly knowledge about relationships among technology, pedagogy, and learning, and a way of asking whether the results justify the university's investment in wireless networks. The assessment of projects like this one should be linked to other assessment of those learning outcomes in undergraduate or graduate program reviews or in assessment of general education.

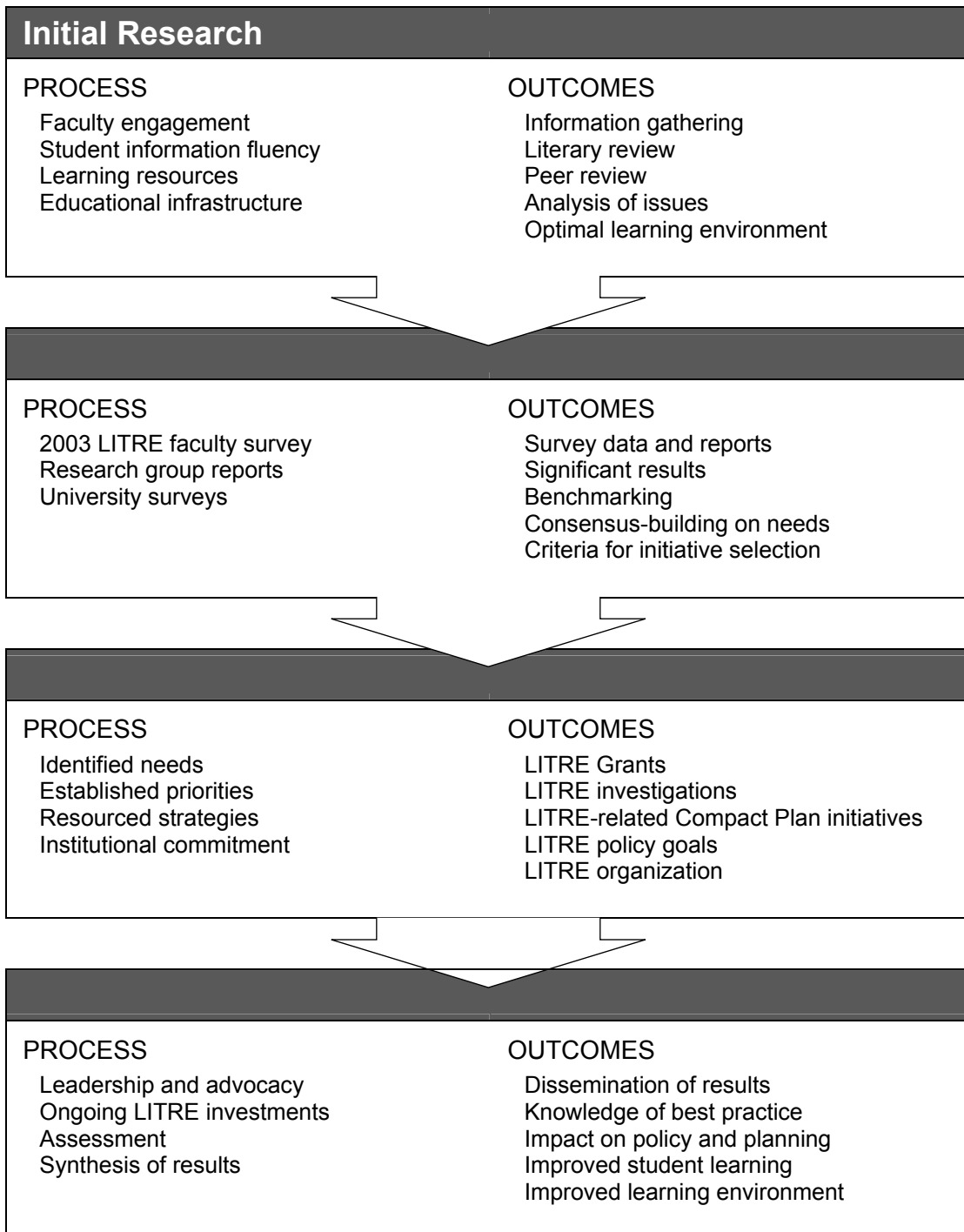
Some of the projects initiated in LITRE's first year will provide general support for students' and faculty members' use of educational technologies. The assessment of such projects is less likely to focus on specific learning outcomes than on student and faculty opinions about whether project activities have helped their teaching and learning in general, and/or whether the project helped reduce barriers to effective learning and effective use of teaching and learning technology.

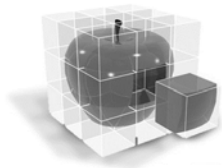
Most LITRE-related assessment will be developed and conducted by the faculty and staff involved in each project. LITRE management will monitor assessment activities and will expand and adjust guidelines and policies as experience shows the most effective approaches and connections. LITRE management will

- provide training in and support for project-specific assessment;
- evaluate the effectiveness of project assessments and the implications of project results indicated by those assessments. These evaluations will help LITRE management encourage relevant new projects, provide feedback to assist ongoing project development, and make appropriate decisions about project continuation;
- develop and conduct ongoing campuswide assessments that serve the overall "LITRE project" itself, such as surveys of faculty attitudes toward instructional/learning technology. These assessments will monitor the general effects of LITRE-related activities and indicate how the university's culture includes using technology to enhance students' learning. Information from these campuswide assessments may also contribute to the development and conduct of individual projects;
- assess and adjust the assessment process itself, as needed, so that project and campuswide assessments guide LITRE planning effectively.

LITRE's path

The following graphic charts the path of LITRE's empirical inquiry. The LITRE team has already completed initial research and preliminary needs assessment. As LITRE continues its work, we will launch initiatives, gather data, and use that data to inform future LITRE projects.





CHAPTER 6

First-Wave Action Initiatives

In selecting topics to be implemented as LITRE's first-wave action initiatives, NC State had to face some hard realities. However appealing, not every perceived need could be met immediately. Like every state in the nation, North Carolina has been struggling to balance rising costs with a reduced general fund. As a result, NC State's budget has been cut every year in the last decade. Although the university has received funds from the state to cover the costs of our growing enrollment, our permanent continuing budget has been cut more than \$129 million since 1994-95. Continuous budget cuts and last-minute reversions to the state general fund have created an uncertain financial climate in which it is difficult to plan ahead.

At this writing, NC State is in the midst of its compact planning process, which will prepare the chancellor, provost, and vice chancellors to make budget decisions quickly after the 2004-05 budget has been approved by the legislature and the UNC Board of Governors. As in most institutions, claims to new resources from the colleges and major administrative divisions greatly exceed the level of resources available. Indeed, we anticipate that the 2004-05 budget, like the 2003-04 budget, will include both permanent cuts and new funding at a lower level than in prior years.

In such a budget climate, careful prioritizing is absolutely essential. The LITRE team therefore embarked on a process to ensure that initiatives included in the first wave of the plan would address the most critical of the needs LITRE had identified and explored as special topics. In the future, the LITRE head will advocate for university action on other already identified critical needs, as well as for new needs that will inevitably arise.

Another hard reality, of course, is that delaying action on some of our critical needs may end up costing more money in the long run. The best way to achieve long-term cost savings is to adopt a proactive approach to planning and resource allocation. Although some immediate large investments may be necessary, a comprehensive and inclusive approach to planning and prioritization of projects can reduce the number of "false starts" that individual units make when they try to solve technology problems on a limited scale. The LITRE team believes that its empirical process will be critically important in disseminating information and helping the university with its long-range technology planning.

Selecting and developing the first-wave action initiatives

In selecting topics for which detailed implementation plans would be developed for the university administration to consider as first-wave initiatives, the LITRE team considered the following criteria:

- Major
 - Greatest impact on learning (tied to curricular goals at departmental, college, or university level)
 - Foundational (logically prior to other initiatives to follow)
 - Sustainable, transferable, scalable
 - Financially feasible
 - Assessable (addresses impact on student learning)
- Minor
 - Broad campus relevance
 - Marketing value (visibility)
 - Politically feasible
 - Technically feasible

These criteria yielded a list of eight implementation plans to be developed during summer 2003. Each plan was to be developed by a team consisting of a few LITRE members, aided by administrators and faculty involved in that area. The LITRE team also agreed to consider initiatives already in development by units on campus. By fall 2003 the team had received twenty-two finished plans. (For sentence summaries of the twenty-two plans, see appendix D).

All plans included the following material:

- an introduction describing the purposes of the initiative, including its expected impact on student learning;
- responsibility for the project;
- steps to be taken, timetable;
- cost and financing plan;
- assessment strategy.

Action initiatives: Building for the future

The LITRE action initiatives approved by the administration for implementation in LITRE's first wave address areas that faculty and the LITRE team had repeatedly identified as critical university needs: facilities improvement, and support for faculty innovation.

Under facilities improvement, LITRE launches four first-wave action initiatives:

Classroom Technology: A classroom-improvement plan

ClassTech: A pilot classroom-improvement project

Harrelson G108: A classroom-improvement project

Flyspace: Workspace improvement for group projects

Under support for faculty innovation, LITRE launches the LITRE Grants program.

LITRE Grants: A plan to encourage faculty innovation

LITRE's first-wave initiatives constitute an important beginning, but they are only a beginning. The LITRE effort is ongoing. As the budget climate improves, the LITRE organization established by this plan will continue to guide the university in identifying and addressing critical needs, aided in this effort by the empirical data we glean from LITRE's initial projects and those funded in the future by LITRE Grants. An additional source of data will be projects launched through the compact plans of individual campus units. (For a list of initiatives relating to LITRE in the current compact plans of units in Academic Affairs, see appendix E.)

Classroom technology: A classroom-improvement plan

NC State envisions a campus with a sufficient number of attractive classrooms fully equipped with appropriate state-of-the-art technologies that faculty can use innovatively to enhance student learning. Classrooms will be equipped in a variety of ways to accommodate all teaching and learning styles in both face-to-face and distributed-learning modes. Scheduled and just-in-time training will be readily available and will promote innovation and experimentation in teaching and learning. The colleges will derive maximum benefit from limited resources by leveraging their resources and by efficient and flexible scheduling.

Progress toward this vision has been uneven. Most classrooms at NC State are designed for delivery of lectures and have not been upgraded to accommodate newly available classroom technologies. The university's current classroom infrastructure falls short of faculty needs. The spring 2003 LITRE Faculty Survey asked faculty what factors would make it easier to use technologies in their courses. The most common response was that technologies needed to be available and supported in their classrooms (37 percent).

Planning to improve classroom technology has been challenging, both because resources are limited, and also because responsibility for classrooms is scattered throughout the university. The Office of the University Architect plans space and designs buildings with classrooms, and Facilities Planning and Design plans, builds, renovates, and maintains the basics of classrooms: walls, windows, desks, chairs, boards, light fixtures, etc. Neither unit is charged with supplying or maintaining technology. In fact, state-allocated repair and renovation funds designated for classroom improvement projects may not be used for technology purchases. Due to the restrictions on R&R funding, the Classroom Hotline, staffed by FP&D, supports only those problems having to do with basic classroom infrastructure—not problems with classroom technology.

ITD provides equipment for and supports only the twelve classrooms recently equipped under the ClassTech pilot project. DELTA equips and supports only those classrooms used for distance education classrooms. Neither unit is responsible for technology in the rest of the university's classrooms. Where technology in other university classrooms exists, it is provided, maintained, and supported by the academic department that has priority scheduling of that classroom.

The diffusion of responsibility for classroom technology has complicated progress toward NC State's goal of providing adequate instructional technology and coordinated support for every NC State classroom. Although staff responsible for various aspects of classrooms have developed hotlines, referral networks, and other strategies to coordinate their efforts, inefficiencies keep NC State from making the best use of the limited resources we have.

- Faculty often do not know whom to call for on-the-spot assistance with equipment or to report damage. Because they cannot be certain what equipment will be available or what support is available, they are frequently reluctant to teach in buildings outside their own college. This reduces scheduling flexibility.
- The current system for scheduling classrooms does not accommodate emerging pedagogical styles. For example, some classes may need certain classroom technologies or classroom features only monthly, not for an entire semester. More flexible scheduling is difficult to coordinate, but it allows more efficient use of expensive and scarce resources.
- Colleges who have made sizeable investments in classroom technology to accommodate unique disciplinary requirements want to protect and control their investments. This is reasonable, but it poses a challenge to improving coordination and efficiency generally across the university.
- The lack of a central inventory of classroom technology makes planning for and coordination of support and maintenance difficult.
- The lack of a more comprehensive coordinating mechanism probably allows some support and maintenance needs to “fall through the cracks” and may waste resources.

NC State is already committed to making dramatic improvements in its classroom infrastructure. The 2000 higher education bond referendum, which provided \$468 million for renovations and new construction, added to NC State's own commitment of \$57 million in additional capital improvements, has given NC State the opportunity to increase its number of classrooms by 20 percent. In anticipation of this classroom buildout, Facilities Planning and Design has developed new standards for supplying classroom technology.

The LITRE project will help NC State shape its plan for improving its classroom infrastructure. This Classroom Technology project develops the information that will be needed to plan and evaluate classroom

technology, helps to develop a strategic plan for classrooms, and helps to develop a plan for coordinating classroom management.

Responsibility for the project

The provost and the vice chancellor for finance and business will co-sponsor this evolving initiative.

Implementation of the project

While the final direction of this initiative is not yet clear, we know enough now to take the first two steps: establishing the information base necessary for improved coordination, and developing a comprehensive coordinating mechanism.

Inventory and evaluation

The Facilities Division and ITD will update the university's classroom inventory, which has not been updated since 2000. This inventory will be expanded to include a list of equipment, its age, its functionality, and how it was funded. Each classroom will be evaluated against newly established classroom technology standards. This information will be summarized into an evaluation of classrooms university-wide. The inventory and evaluation will inform planning for future investments in new building, renovations, equipping, maintaining, scheduling, and supporting classrooms.

Project leaders are Angela Lord (FP&D) and Stan North Martin (ITD). Costs associated with the inventory will be paid by the Facilities Division.

Timeline: Summer 2004

Cost range : \$15,000 to \$20,000 (one-time), FY05

Coordinating mechanism

Although there is widespread agreement about the value of greater coordination in classroom management, there has been little effort to bring all units together to discuss how to achieve it. The LITRE project has stimulated progress. First, in fall 2002 LITRE brought the need to improve classroom technology to the attention of the provost, who allocated \$196,000 for this purpose, launching the ClassTech pilot project. Second, in gathering information for this plan, the LITRE team found a high level of agreement with its vision and with the need for a comprehensive approach to improved coordination.

The first step will be a campus retreat or forum attended by representatives of each unit responsible for some portion of classroom design, construction, equipping, maintenance, scheduling, and support. Participants will share information about their unit's contributions to classroom planning and management. In addition, forum participants will be asked to draft a charge for a task force that will develop a strategic plan for classroom development and recommend changes for improved coordination among the various units. Specifically, the task force would be asked to

- recommend a strategic plan for classroom development;
- recommend an overarching administrative mechanism to plan for and oversee classroom construction, maintenance, equipment, and improvements;
- clearly define the roles of and partnerships among all units with any responsibility for classrooms;
- consider the costs and benefits of a coordinated classroom-support unit, which will purchase hardware and software, provide responsive support, plan classrooms, consult on technology renovations and improvements, and train faculty;
- recommend the level of permanent, adequate, and readily available resources for repair, maintenance, improvement, and security of classrooms and classroom technologies;
- develop a regular schedule for updating and evaluating the classroom inventory.

The forum planning team includes Katie Perry (Provost's Office), convenor, Sharon Pitt (Learning Technology Service), Angela Lord (FP&D), Cindy Williford (Office of the University Architect), Stan North Martin (ITD), Michelle Johnson (R&R), and Ed Funkhouser (College of Humanities and Social Sciences). Several of these individuals are members of the Classroom Environment Committee.

Timeline: Spring 2004

Cost: The Facilities Division will absorb any costs associated with the forum. Task force recommendations will likely result in new costs or in reallocated expenditures as early as FY05.

ClassTech: A pilot classroom-improvement project

In fall 2002 the division of Facilities Planning and Design, in conjunction with many other campus units, completed new design standards for classroom technology. These standards established five levels of classroom-technology design and specified the equipment to be available at each level. Revision of these standards is ongoing.

In early spring 2003, the Classroom Environment Committee recommended a pilot project to help NC State get started bringing its classrooms up to the new standards. Then-interim provost Robert Barnhardt approved this pilot project, allocating \$196,000 for FY 2003, plus additional funding for installation in FY 2004, and money for maintenance in subsequent years. The pilot project is known as ClassTech.

Responsibility for the project

The principal investigators for this project are Stan North Martin, associate director of computing services, ITD; and a faculty member with research expertise and interest in the use of technology in teaching and learning. The development, testing, implementation, and assessment of this pilot will require the collaboration of faculty teaching the sections that are the object of this research, and faculty and staff from the Classroom Environment Committee, Learning Technology Service, Registration and Records, and University Planning and Analysis.

Implementation: Procedures and timeline

With guidance from the Office of the University Architect and other units, the Classroom Environment Committee has identified twelve classrooms on Main Campus to bring up to the new technology standards. The selected classrooms represent a variety of room capacities in a variety of buildings that are heavily used by a variety of different departments. The project includes not only technology equipment but also funding for maintenance and support. The equipment required was purchased and installed during 2003, and the upgraded classrooms will be ready to use in spring 2004.

2003

- Identify twelve Main Campus classrooms to be included in the pilot (Classroom Environment Committee, Facilities Planning and Design, Office of the University Architect, Registration and Records, ITD).
- Purchase and install equipment (ITD).
- Identify partners for assessing the effectiveness of classroom improvements.

Spring and summer 2004

- Pilot the newly equipped classrooms with faculty already assigned to use these rooms.
- Identify instructors to participate in more rigorous outcomes assessment and assign to technology classrooms for fall 2004 (PIs/Registration and Records).
- Review course/program assessment plans to ensure that they address technology-enhanced aspects of the course (PIs).
- Conduct initial surveys on equipment usage and support (ITD).
- Develop specific surveys and assessment methods for student learning and faculty's adoption of technology use (ITD/PIs with assistance from UPA).
- Develop procedures to provide technical assistance for faculty using pilot classrooms (ITD).
- Identify and train tech support staff (ITD).

Fall 2004 and spring 2005

- Pilot the newly equipped classrooms.
- Survey faculty, students and staff to assess learning outcomes (ITD/PIs).
- Collect data from maintenance records (ITD).

Summer 2005

- Prepare summary report (PIs).
- Recommend next steps (PIs).
- Recommend scale-up possibilities to LITRE (PIs).

Budget

All funds for ClassTech have already been allocated or promised by the provost. No request for additional funds are being requested at this time. Funding levels are:

- FY03: \$196,000 budgeted (one-time, temporary allocation), with \$150,000 actually expended
- FY04: \$169,000 budgeted (one-time, temporary allocation), plus \$81,300 budgeted (permanent allocation) for support and maintenance of these twelve classrooms
- FY05: \$25,700 additional budgeted to be added to permanent funding

This budget does not include in-kind contributions from ITD, LTS, UPA, and other units for whom ClassTech will be a priority.

Additional funding in the \$3,000 to \$5,000 range might be necessary for assessment, which should be included in the LITRE organization budget. Additional one-time funding would be needed to upfit additional classrooms (see Classroom Technology project) and to provide ongoing support and maintenance.

Assessment

The assessment of this pilot will amass data on student learning in the newly equipped ClassTech classrooms. Initial data will be collected in spring 2004 about equipment usage, operability, maintenance, and training, with more detailed assessment on student learning beginning in fall 2004. The results of this assessment will be useful in refining the classroom technology standards, in applying those standards to future construction and renovation, in setting priorities for classroom improvements, and in training faculty to use the classrooms.

Specific surveys and assessment methods will be developed in spring and summer 2004 by ITD and the principal investigators, with assistance from UPA. Three aspects of the pilot project will be assessed.

Does the technology help students achieve course and program objectives? Undergraduate classes will be assessed on the basis of existing undergraduate program and course assessment plans. If the existing assessments do not address technology-enhanced aspects of the course, faculty will be asked to develop additional assessment exercises. Graduate classes will be assessed on the basis of analogous assessment plans to be developed by faculty. The existing assessment plans vary with the program, course topic, and course level, but all involve explicit objectives, outcomes, and methods for assessing student achievement of those outcomes. Assistance in refining the plans will be available from faculty and staff associated with Undergraduate Academic Program Review, the Division of Undergraduate Affairs, University Planning and Analysis, and the Faculty Center for Teaching & Learning.

Does the technology affect how faculty members teach and how students learn? To answer this question, ITD will survey faculty and students who use the pilot classrooms. Faculty will be asked how they used the equipment in their courses and how having it available affected the way they designed and taught the courses during the pilot. Students will be asked whether having the technology available and used in the course affected the way they worked in class and on course assignments.

Are adequate support and training provided for faculty members to use the technology effectively? To answer this question, ITD will survey faculty and students to ask about the training and support they received in using the equipment, and about the availability, reliability, and maintenance of the equipment. In addition, the team will survey ITD support staff and review ITD's repair and maintenance requests.

Harrelson G108: A classroom-improvement project

Although it is widely acknowledged that computer technology by itself does not improve learning outcomes, technology can help create an enriched environment in which learning is more likely to occur. Harrelson G108 is an experimental classroom where Physical and Mathematical Science instructors develop and test new instructional models.

HA G108 is used in one of NC State's most successful experiments in using technology to improve student learning, Student-Centered Activities for Large Enrollment Undergraduate Programs. SCALE-UP promotes active learning: Class time is spent primarily on hands-on activities, simulations, or interesting questions and problems.

During classes in HA G108, ninety-nine students sit at eleven round tables, working on problems and projects in small groups. Each table has about seven laptop computers. Through technology applications, faculty are able to give students in HA G108 frequent and timely feedback, and can use question formats that are more flexible than are typical in standard introductory physics courses. The instructional model they have adopted results in lower failure rates among at-risk populations such as minorities and women. Putting technology in the hands of the students affords new learning opportunities, but it also creates technical and classroom-management issues.

The computing environment in HA G108 is currently a customization of the standard Unity lab configuration, which has proved to be inappropriate for the kinds of teaching for which this room is used. This project will develop a new software environment tailored to computing in the classroom, including a new configuration of the operating system, new networking parameters, and new installation procedures. The goals of this new system are improved speed, reliability, flexibility, and instructor control.

Responsibility for the project

The development, testing, and implementation of the new system will require the collaboration of faculty and staff from the Department of Physics, the College of Physical and Mathematical Sciences, and ITD. Physics professor and HA G108 instructor John Risley will serve as principal investigator. Other members of the project team will include other physics professors Robert Beichner, Ruth Chabay, and Bruce Sherwood; mathematics professor Larry Norris; and chemistry professor Maria Oliver-Hoyo. Additional HA G108 instructors for fall 2004 will be identified. Input will be solicited from students in courses taught in HA G108 during fall 2004. Pete Evans and Steve Jenkins from the PAMS IT group, and Dan Green from the College of Engineering's IT group will be significantly involved, as will Debbie Carraway from ITD, and Mladen Vouk, associate vice provost for information technology. University assessment director Ephraim Schechter will consult on the assessment plan.

Implementation: Procedures and timeline

Spring 2004

- Summarize ongoing surveys and interviews of students and faculty using HA G108 to identify what works and what doesn't (PI).
- Conduct baseline assessment of student motivation and ability to concentrate in class (project team).
- Identify instructors who will use HA G108 in fall 2004 and participate in the project (PI).
- Develop specifications for, evaluate alternative software solutions, and select the best approach (project team).
- Begin to develop new load solution (project team and programmer).
- Install and field-test first set of software (project team).
- Gather feedback and refine model (project team).
- Implement on ten laptops for more field-testing and feedback (project team).
- Add network controls to limit access to Internet as needed by faculty (project team).
- Develop procedures to provide emergency assistance for faculty using HA G108 (project team).
- Identify and train tech support staff (project team).

Summer 2004

- Migrate all laptops to new classroom load; test (project team).
- Test software, networking, and computer installation (tech support staff, demo room staff, and programmer).
- Design assessment tools (project team and consultant).

Fall 2004 and spring 2005

- Pilot the load solution in classes (project team).
- Evaluate solution under conditions of actual classroom use (project team).

Summer 2005

- Prepare summary report on lessons learned (PI).
- Recommend next steps (PI).
- Recommend scale-up possibilities to LITRE (PI).

Budget

All costs for this project are non-recurring. They include faculty release time, programming, technical support, equipment, software, and consulting, summing to roughly \$100,000. The provost will contribute programming costs, equipment, and software, and the Department of Physics will provide faculty release time and technical support.

	FY04	FY05	Source of Funding
Principal investigator (Risley), tech support	\$15,000	\$42,000	Physics
Programmer	\$20,000		Provost
Equipment and software		\$22,000	Provost

Assessment

A stable and appropriate classroom configuration is a prerequisite for learning. The immediate goals of this project are improvements in the speed, reliability, flexibility, and instructor control of the instructional software environment. Accordingly, assessment in the first phase will focus on the extent to which these goals have been reached. Specifically, investigators will compare end results with baseline data they are now collecting on:

- average login time under load
- average number of login failures per class
- failures to bring up applications
- ability to connect lab equipment
- ability to install new software
- ability to disable Instant Messenger

A parallel, ongoing assessment by Physics Education Research faculty will focus on factors that facilitate student learning by reducing distractions and other “technical noise.”

Assessment results will be used to identify factors affecting scalability of the solution tested in HA G108 and adaptability to other classrooms across campus.

Flyspace: Workspace improvement for group projects

NC State's student learning environment does not accommodate group projects well. Most conferencing facilities on campus were developed for the use of faculty and staff. Students have few options for scheduling a conference in a public facility, and none in a videoconferencing facility. Computer labs are designed for individual work and discourage conversation. Students involved in team collaboration have to meet in lunch halls, the library, or dorm rooms, where they have to cope with issues like noise, lack of seating appropriate for groups, lack of flat work surfaces, and uncertain computer connectivity.

The Flyspace pilot project will establish and test the effectiveness of well-equipped, technology-enabled workspaces for student group projects. The goal is to create a collaborative work environment that is inexpensive, easy to use, and requires minimal support. If the pilot is successful, NC State can add technology to single-function public computing facilities, lounges, and study spaces, and convert them to multi-function spaces that accommodate student study and collaboration.

Responsibility for the project

The Flyspace pilot project will be overseen by a project team headed by co-principal investigators Hal Meeks in the Information Technology Division (ITD) and a faculty member (to be named). Other members of the project team will include Carolyn Argentati (NCSU Libraries), Don Patty (Talley Student Center), Bill Padgett (ITD), Sharon Pitt (Learning Technology Service), Ephraim Schechter (University Planning and Analysis), representatives of the Tutorial Center and the Faculty Center for Teaching and Learning, and faculty and students using the space.

Establishing and supporting Flyspaces

Three rooms have been identified for the pilot project—one in the Libraries' Learning and Research Center for the Digital Age known as the Collaboratory, and two in the Talley Student Center.

The Collaboratory at D.H. Hill Library is equipped with a PC and a Macintosh computer, each equipped with a large, 23-inch display for viewing by a small group, and with software for creating presentations and manipulating multimedia materials created in the nearby Digital Media Lab. Seating is available for two groups of six to eight people. Videoconferencing equipment can be reserved for use in the room, and wireless networking is available. Networked printing is available from printers in the Digital Media Lab. Equipment and furniture will be added to the Collaboratory as recommended by the project team based on the findings of the Flyspace pilot project.

Each room in Talley will be equipped with a rectangular table and flexible seating for up to five people. The table will have security boxes mounted from below to hold up to four computers and capability for additional hook-ups (power/networking) to personal portable computers. Some of the other elements in the space will include: whiteboards along the walls; computer workstations tied together with screen-sharing software and screen take-over software; network and power connections for laptops; a large (approximately 21-inch) display that can be controlled by a switch panel; and a videoconferencing camera with a wide-angle lens to interact with remote participants. Technology will be there to assist, but it will not dominate the environment. Computers and compact LCD panels will be mounted on arms so that they can be pushed out of the way to maximize table space.

Students and faculty will be able to reserve these spaces through the Libraries' Website, by telephone to the Digital Media Lab, or by visiting the Talley Student Center reservations desk.

Technical support for the Libraries' Collaboratory will be provided by LRCDA staff. The Information Technology Division and Talley Student Center technology support teams will provide technical assistance in the Talley Student Center. The operating budget provided is for ongoing facilities and user support as well as development of scheduling systems and software integration in these rooms.

Implementation: Procedures and timeline

Spring 2004

- Talley Student Center creates two rooms.
- LRCDA promotes use of the Collaboratory and plans for future upgrades.
- Project team solicits and identifies faculty members willing to assign group projects to be completed using Flyspaces.
- Project team tests usability of Flyspaces and develops detailed assessment plan.
- Talley Student Center manages reservations for its two rooms.

Fall 2004 and spring 2005

- Project faculty include Flyspace assignments in their courses.
- Project team promotes use of Flyspaces to students.
- Project team assesses student learning, faculty/student use of and satisfaction with Flyspaces.

Summer 2005

- Project team completes an overall assessment report for submission to the LITRE Advisory Board for review and dissemination.

Budget

Resources needs associated with this project include equipment, renovations, and ongoing support and maintenance.

The Libraries has already committed the space and equipment necessary for the initial phase of this project. The Talley Student Center, in conjunction with ITD, has committed the space, the provost will provide funds to equip and furnish two rooms. The provost will also provide recurring funds for technical support, user assistance, maintenance, and operating in Talley, and the Libraries will provide support in the LRCDA.

	FY04	FY05	Source of Funding
One-Time Costs			
Create 2 rooms in Talley	\$25,000		Student Affairs
Equip, furnish 2 rooms in Talley	\$22,500		Provost
Equip, furnish 1 room in LRCDA	\$15,000		Libraries
Recurring Costs			
Support and operating in Talley		\$7,500	Provost
Support in Libraries		\$3,340	Libraries

Assessment

We will use at least two strategies to assess Flyspace.

We will assess students' academic performance on group projects assigned to Flyspace, possibly comparing it to students' performance on group projects without Flyspace.

We will collect usage data on Flyspace from students and faculty (why, when, how they used Flyspace) and will ask about their satisfaction with various aspects of the rooms and equipment.

Specific details will be developed after the faculty member(s) join the project team, so that we can use learning objectives associated with the group project and/or course as the basis for assessing student learning.

LITRE Grants: A faculty-support plan

In responding to the 2003 LITRE Faculty Survey, both undergraduate and graduate faculty decried the lack of resources (time, staff, funding) at NC State to develop technology-based assignments for students. LITRE Grants provides resources to NCSU faculty and staff to support planning, design, and development of high-quality, technology-enhanced learning materials, learning technologies, courses, and programs at the course, departmental, and multi-departmental levels. LITRE Grants will build a collection of best practices from which faculty can draw for future projects.

To ensure that awarded projects focus on student learning, LITRE Grants will encourage the development of projects that:

- develop student-technology skills, as defined by NC State's general education requirements;
- incorporate advanced and discipline-specific learning and/or technology skills in support of defined departmental curriculum goals;
- enrich the technology fluency of students at NC State across the curriculum;

Support for development of new software/hardware or teaching methodologies is not an add-on; it is wholly consistent with faculty development in research areas. If NC State wishes to be recognized as a leader in providing top-level education, such support is not superfluous. It is essential.

Description of LITRE Grants selection structure

LITRE Grants is an independent initiative that will profit from the administrative structure of the current DELTA IDEA Grants program, while eliminating its restriction to distance education. LITRE Grants will be open to any instruction at NC State, whether in the traditional classroom or anywhere across the distributed technology-education environment. The LITRE Grants structure will include:

- well-coordinated and documented grant-program processes;
- a timeline that serves the needs of faculty;
- grant-submission workshops and consultations;
- reviews at departmental and college levels;
- an inclusive, fair, and systemic proposal-review process;
- defined budgetary processes;
- on-line project tracking and reporting;
- defined programmatic assessment.

Criteria for project selection will include:

- a strong impact on student learning;
- clearly stated and practical project goals;
- endorsements from program chairs and/or department heads;
- clearly articulated roles, responsibilities, and partnerships within the project plan;
- a reasonable and accountable budget plan;
- a clear and appropriate plan for assessing project objectives;
- potential for ability to scale within a discipline and complement a degree program;
- potential to translate to other disciplines.

Responsibility for the project

LITRE Grants is designated as one of the core responsibilities of the LITRE head.

Implementation: Timeline and procedures

2004-05: LITRE leader plans the program, announces RFP, awards grants

2005-06: Launch and assess first LITRE Grants; award next LITRE Grants

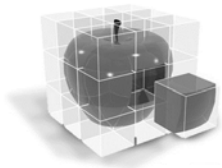
Budget

The budget for LITRE Grants will be determined in consultation with the LITRE head after that person is named, and after more is known about the availability of funds for FY05. The program may be phased in over two years as funds become available. Eventually, grant awards will sum to \$100,000 annually, and the program will require administrative and production support.

Assessment

Two surveys will be developed to assess the LITRE Grants program. One will be administered to the grants staff and one to the faculty submitting proposals. These surveys will measure internal efficiency, perceptions of individuals who applied for grants, and effectiveness in reaching program goals.

A variety of assessment expertise across the institution will help grant recipients develop appropriate methods for evaluating individual projects. Such metrics might address faculty and student satisfaction or student performance. Grant recipients will be required to submit a detailed mid-year project report and an end-of-year project report. Mid-year and end-of-year reports will be reviewed to determine if there is sufficient progress to justify continuation.

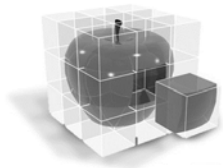


Conclusion

Changing student demographics and emerging instructional technologies have taken North Carolina State University to the cusp of transformation, a moment when the university can tap into unique and creative ways to teach and learn.

To meet the expectations of the next generation of NC State students, NC State must address critical gaps in our current learning environment and educational infrastructure. Investments to address these gaps must be effective, both fiscally and pedagogically. LITRE's goal is not simply to build infrastructure; it is to build a learning environment tailored to the needs of NC State's students. The learning environment includes a range of technologies, but it also includes instructors, programs, and the undergraduate curriculum as a whole. The drivers of the choices NC State must make are the faculty. Their ability to make good judgments about what type of technology will further key student outcomes is essential to the LITRE effort.

The LITRE plan launches an empirical research process that will help NC State apply technology to enrich learning. Success in this endeavor will help NC State build a high quality, competitive academic environment that produces NC State graduates who are differentiated from their peers by their superior ability to harness technology to reason, investigate, and communicate.



APPENDIX A

Definition of “Learning”

Student learning at NC State: Four ways of knowing and doing

1. Problem solving

Definition. A way of knowing and doing that involves an initial state and an end state and some difficulty in moving from the initial state to the end state and consists of overcoming the difficulty and attaining the end state.

Common ways of knowing and doing. (1) Finding or being given a problem; (2) defining the problem; (3) determining various possible solutions, ways of attaining end state; (4) evaluating the solutions; (5) applying the optimal solution to the problem.

Variations. (1) designing a product; (2) applying specialized knowledge; (3) finding sources that provide pertinent information.

Question for technology education: What kinds of technology and technology education do we provide students to best enable them to solve problems in ways appropriate to their fields of study?

2. Empirical inquiry

Definition. A way of knowing and doing that consists of answering questions by drawing conclusions from systematic inquiry based on empirical data.

Common ways of knowing and doing. (1) Asking or being given a research question; (2) designing or being given a research method for answering the question; (3) applying deliberate and thorough observational skills; (4) organizing, summarizing, and presenting data; (5) coming to conclusions based on the data.

Variations. (1) hypothetical empirical inquiry; (2) descriptive empirical inquiry; (3) prospective empirical inquiry.

Question for technology education: What kinds of technology and technology education do we provide students to best enable them to engage in empirical inquiry appropriate to their fields of study?

3. Research from sources

Definition. A way of knowing and doing that involves academic investigation using primarily library and Internet resources, the “research paper.”

Common ways of knowing and doing. (1) Asking or being given a research question; (2) locating relevant primary and secondary sources to answer the question; (3) critically evaluating the sources; (4) marshalling the evidence to answer the research question.

Variations. Varies according to discipline. Doing the research is not an end in itself, rather a means of learning about and entering into the conversation of the discipline.

Question for technology education: What kinds of technology and technology education do we provide students to best enable them to engage in academic research appropriate to their disciplines?

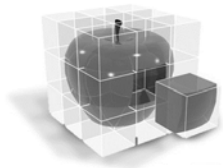
4. Performance

Definition: A way of knowing and doing that results in an artifact which has value in and of itself but, more importantly in terms of learning, as direct evidence of the performance, a student’s ability to successfully apply art and technique.

Common ways of knowing and doing. Depends on the discipline.

Variations. Depends on the discipline.

Question for technology education: What kinds of technology and technology education do we provide students to best enable them to engage in the modes of performance appropriate to their disciplines?



APPENDIX B

Bibliography

Bibliographic essay

The goal of the LITRE project is not the mere enhancement of NC State's technology-rich environment, but rather the enhancement of that environment in such a way as to improve student learning.

A sensible early step was to examine the scholarly literature on this topic. Conventional wisdom is that this literature is inconclusive and scattered, and, indeed, we found it to be inadequate in many ways. In one way, however, the literature is startlingly conclusive. On the simple question of whether there is any measurable benefit to learning outcomes attributable to technology-enhanced course delivery, the conclusion of the scholarly literature is unequivocal: No. It's not worse, but it's not better either. Statistically, the difference in learning outcomes is not significant.

The most convincing scholarly work on this topic was done right here at NC State. In 1999, Thomas L. Russell, the director of NC State's Instructional Telecommunications program, published an annotated bibliography of 355 research reports, summaries, and papers published since the 1920s and comparing learning benefits of delivery systems using different media (*The No Significant Difference Phenomenon: A Comparative Research Annotated Bibliography on Technology for Distance Education* [iDECC, 1999]). The clear evidence of Russell's research is that the benefits to learning provided by different media delivery systems are not statistically significantly different.

This finding has major implications for universities concerned with conserving scarce resources. As Richard E. Clark points out in the foreword to the volume, "The point is that no matter who or what is being taught, more than one medium will produce adequate learning results and we must choose the less expensive media or waste limited educational resources" (viii).

Russell's bibliography is a good starting place, but it is not exhaustive. The goal of the LITRE effort, after all, is to enhance the entire technology-rich environment at NC State, not just technology-based course-delivery systems. Broadening the scope of our research, however, did not substantially change our conclusions.

The literature on learning with technology, both on the narrow course-delivery topic explored by Russell and on the larger questions addressed by the LITRE project, is copious but of dubious quality. For the most part, articles on this topic are not subject to peer review, or for that matter, to independent review of any sort. The lion's share of the literature consists of case studies of innovative projects or practices specific to individual campuses. Usually written by project administrators, most of these studies have the character of annual reports and puff pieces rather than critical evaluations. Though many call themselves examples of "best practices," the applied publishing standard begs the question of what "best" could possibly mean in this context. The studies are seldom comparative, longitudinal, benchmarked, or controlled in any meaningful way. It is hard to avoid concluding that using such case studies to anchor our quality enhancement plan would be reckless--unless we perform the requisite critical evaluations ourselves.

We can take several steps to do this. First, to narrow the field, we can limit our literature review to case studies of institutions that are comparable in size and mission to NC State. Second, to gain some measure of independent review, we can give greater credence to reports of projects that went through a grant procedure at initial stages. Third, we can perform followup evaluations of our own. At a minimum, we need to ensure that the studies describe projects that survived the initial stages and were mainstreamed by their own institutions. The following annotated bibliography begins LITRE's efforts to compile a list of responsible, relevant scholarship on the LITRE topic.

Select annotated bibliography

Arnone, Michael. "Online Education Must Capitalize on Students' Unique Approaches to Learning, Scholar Says." *Chronicle of Higher Education*, 2 March 2002.

According to Nishikant Sonwalkar, principal educational architect at the Education Media Creation Center at the Massachusetts Institute of Technology, online education must allow students to learn according to their personal styles. Sonwalkar says that online learning has a lot more potential for accommodating the individual learning experience than the way it is currently used. To meet that potential, institutions must think about content and media in terms of learning strategies; turn static pages into dynamic pages; and provide interactivity.

Barr, Robert B., and John Tagg. "From Teaching to Learning—A New Paradigm for Undergraduate Education." *Change* (Nov./Dec. 1995): 13–25.

Universities should aim to produce not instruction, but rather learning. Learning-centered institutions value student outcomes. In learning-centered institutions, learning structures are holistic, valuing the whole over the parts. Learning is adapted to the needs of students, which means that learning-centered universities enrich learning environments and relax constraints on time and space. In learning-centered institutions, faculty design learning environments, but are not independent actors. Rather, faculty share governance and work on teams.

Butler, Darrell, and Martin Sellbom. "Barriers to Adopting Technology for Teaching and Learning." *EDUCAUSE Quarterly* 25, 2 (2002): 22–28.

Ball State University surveyed 410 faculty (response rate 30 percent) to assess its faculty's adoption of instructional technology. The results suggest four major barriers to adopting technology: unreliability; lack of time to learn to use new technology; skepticism that using technology improves student learning; dissatisfaction with campus support in solving problems with technology systems. The article recommends ways to reduce or eliminate these barriers.

"Faculty cannot easily find convincing data that technology matters, nor can they easily determine if this is because technology doesn't matter or because the right studies aren't widely available" (26).

Fear, Frank A., Diane M. Doberneck, and Carole F. Robinson. "Meaning Making and 'The Learning Paradigm: A Provocative Idea in Practice.'" *Innovative Higher Education* 27, 3 (Spring 2003): 151–68,

In their seminal 1995 *Change* article, Robert Barr and John Tagg proposed a new vision for undergraduate education that they called the "Learning Paradigm." Colleges governed by this paradigm conduct organized and systemic efforts to develop environments and experiences that allow students to discover and construct knowledge for themselves, make students members of communities of learners, and create a series of ever more powerful learning environments. This article reports on the collaboration of a liberal arts college and a public university in investigating, expanding, and implementing their understanding of this learning paradigm.

Hagner, Paul R. "Interesting Practices and Best Systems for Faculty Engagement and Support." <http://www.educause.edu/ir/library/pdf/NLI0017.pdf>

Success in implementing learning technologies depends on whether a university has developed an institution-specific plan that takes into account the attitudes of the faculty toward technology, and the level of trust between faculty and administration. The report includes case studies of universities that have done well in the broad categories of training, grants, technical assistance, information exchange, and assessment.

Hazemi, Reza and Stephen Hailes, eds. *The Digital University: Building a Learning Community. Computer Supported Cooperative Work*. London, Eng.: Springer-Verlag, 1996. 252 pp.

To secure the long-term future of an expanding higher education system, universities must make a sustained effort to improve the effective and efficient use of resources. One factor in achieving success will be the adoption of suitable communications and information technology strategies. The sixteen chapters of this book consider ways to improve the efficiency of higher education institutions through the thoughtful application of asynchronous collaboration.

Heterick, Robert C., Jr., James R. Mingle, and Carol A. Twigg. "The Public Policy Implications of a Global Learning Infrastructure." A Report from a Joint NLII-SHEEO Symposium. Denver, Colorado, 13–14 November 1997

<http://www.educause.edu/nlii/keydocs/policy.html>

Higher education will face many challenges in the next century and must make informed decisions about information-technology financing and investment strategies. Suggestions presented draw from views of twenty-five state representatives, educators, and policy experts.

Heterick, Robert C., Jr., and Carol A. Twigg. "The NLII Vision: Implications for Systems and States." NLII-SHEEO Seminar on the Public Policy Implications of the Information Technology Revolution. Denver, Colorado: 13–14 November 1997.

<http://www.educause.edu/nlii/keydocs/publicpolicy.html>

Information technology affects the ways we regulate, organize, and finance higher education in the United States, including the competitive environment brought about through digital networks, the variety of change strategies open to states and systems of higher education, and the kinds of financing policies that can lead to cost-effective delivery of higher education to future generations of students.

Johnstone, D. Bruce. *Learning Productivity: A New Imperative for American Higher Education*. Studies in Public Higher Education. Albany, N.Y.: State University of New York, 1992.

<http://www.educause.edu/nlii/articles/johnstone.html>

We can enhance academic productivity by increasing higher education's output—mainly student learning—in a way that delivers the same or more educational quality but for less money.

Katz, Richard N., and Diana G. Oblinger, eds. *The "E" Is for Everything: E-Commerce, E-Business, and E-Learning in the Future of Higher Education*. Vol. 2: Educause Leadership Strategies. San Francisco: Jossey Bass, 2000. 118 pp.

As the electronic services revolution continues, student and faculty learning, communication, and socialization styles and proclivities will inevitably change, and administrative services will migrate to electronic means. The leaders of today's colleges and universities must make profound and far-reaching institutional commitments to handle these changes and must accompany them with investments of talent and funds. The six essays in this book present and analyze relevant data, technical, and policy issues.

Marchese, Theodore J. "A Shift to Learning." *Change* 29 (March/April 1997).

In their 1995 *Change* article, "From Teaching to Learning: A New Paradigm for Undergraduate Education," Robert Barr and John marked the limits of teaching within a larger system that values efficiency in credit-hour production. Much of the new knowledge about learning challenges the received theories, points the way to more powerful pedagogies, and tells us that there is a paradigm shift awaiting us. Nonetheless, there are not many people who think there is a problem with learning in higher education, and a lot of today's talk about "learning" has too little behind it.

Massy, William F., and Robert Zemsky. *Using Information Technology to Enhance Academic Productivity*. White paper on academic productivity. Educom's National Learning Infrastructure Initiative, 1995.

<http://www.educause.edu/nlii/keydocs/massy.html>

Infusing information technology into the education can reverse the declining productivity of American higher education.

National Research Council. *Enhancing Undergraduate Learning with Information Technology: A Workshop Summary*. Edited by Margaret Hilton. Center for Education, Division of Behavioral and Social Sciences, National Research Council. Washington, D.C.: National Academy Press, 2002. 98 pp.

Information technology enables exciting new approaches to undergraduate science, mathematics, engineering, and technology education. At a workshop held at the National Academy of Sciences in June 2000, scientists, policymakers, and researchers discussed developments in IT and presented good practices. Although workshop participants believed that IT can support improved education, most agreed that there is nothing inherent in the new technologies that would determine improvement. Furthermore, when IT is used for administrative purposes, it does not help students understand and master material. Workshop participants focused on

pedagogical innovations that can improve learning by matching pedagogical methods to individual students' learning styles. The new pedagogical paradigm will be learner centered, practical, and collaborative, with students and faculty engaging in active learning and problem solving together. Case studies from San Diego State University, the University of Houston, the University of Massachusetts—Dartmouth, and the University of Maryland.

Oblinger, Diana G., and Sean C. Rush, eds. *The Future Compatible Campus: Planning, Designing, and Implementing Information Technology in the Academy*. Bolton, Mass.: Anker Publishing Co., 1998. 280 pp.

Although the plan for creating a future compatible campus is unique to each institution and its culture, successful plans have common critical elements including deliberate planning, transformation, and a focus on productivity and individualization. The “future compatible campus” is a connected campus—a technology-enabled environment that consists of three components: connected learning, connected service to the community, and connected management. The new approach must be based on networks, communications, and computer technology using learning-on-demand, learner-centered instruction, student-centered services, and digital libraries. The sixteen essays in this book touch themes ranging from strategy to measurement.

Oblinger, Diana G., and Sean C. Rush, eds. *The Learning Revolution: The Challenge of Information Technology in the Academy*. Bolton, Mass.: Anker Publishing Co., 1997. 251 pp.

Colleges and universities must use technology to respond to four institutional requirements: higher productivity, a commitment to quality, increased access, and competitiveness in a student-based market. The fifteen essays in this book share information on how a variety of institutions use technology to respond to these challenges. The editors predict that there will be resistance to change in higher education. Individuals will protect their territory, and education's traditional structures may limit change. The fears of technology must be balanced by its potential.

Russell, Thomas L. *The No Significant Difference Phenomenon: A Comparative Research Annotated Bibliography on Technology for Distance Education*. Raleigh, NC: North Carolina State University iDECC, 1999.

This volume is an annotated bibliography of 355 research reports, summaries, and papers published since the 1920s and comparing learning benefits of delivery systems using different media. The data show that the benefits to learning provided by different media delivery systems are not statistically significantly different. This finding has major implications for universities concerned with conserving scarce resources. As Richard E. Clark points out in the foreword to the volume, “The point is that no matter who or what is being taught, more than one medium will produce adequate learning results and we must choose the less expensive media or waste limited educational resources” (viii).

***Supporting Faculty in the Use of Technology: A Guide to Principles, Policies, and Implementation Strategies*. A report by the Southern Regional Education Board Distance Learning Policy Laboratory Faculty Issues Subcommittee. December 2001.**

http://www.electroniccampus.org/policylab/Reports/Supporting_Faculty.pdf

In a technology-rich environment, the relationship between teacher and student will change, but will continue to be fundamentally important. To sustain progress, we must learn from others and accelerate investments in the “human capital” side of technology. Faculty, instructional designers, technical-support staff, information specialists and librarians, tutors, and students all need continuous training and development to keep abreast of instructional-technology developments. Distance-learning activities are threatened by existing or potential barriers in the areas of access, quality, and cost. The work of this subcommittee pursues three broad goals: (1) To use technology to improve the teaching and learning process; (2) To support new roles for faculty in an e-learning environment and to develop appropriate compensation and incentive structures to support these new roles; (3) To establish equitable policies that allow widespread access to information resources while sustaining the traditional rights of content holders to their intellectual property. The subcommittee makes ten recommendations to achieve these goals.

Tagg, John. *The Learning Paradigm College*. Bolton, Mass.: Anker Publishing, 2003. 400 pp.

A paradigm shift is taking hold in American higher education—one in which the new mission of the institution is to produce learning, not simply to provide instruction. This book offers a new lens through which readers can see their own institutions and their own work. A radically fresh perspective examines existing functional frameworks and offers a way to reenvision and recast many familiar aspects of college work and college life. Eminently clear, accessible descriptions of the features of the Learning Paradigm are paired with actual and uplifting examples of how institutions of higher education around the country are transforming themselves into Learning Paradigm colleges. The Learning Paradigm college is vital, optimistic, and realistic about what all those involved in higher education can achieve.

The book is divided into five parts:

Part I introduces the Learning Paradigm

Part II concentrates on understanding our learners

Part III provides a framework for producing learning

Part IV discusses the six essential features of the Learning Paradigm college

Part V focuses on how to become a Learning Paradigm college

Twigg, Carol A. *Academic Productivity: The Case for Instructional Software*. A Report from the Broadmoor Roundtable, Colorado Springs, Colo., 24–25 July 1996.

<http://www.educause.edu/nlii/keydocs/broadmoor.html>

Software-based, learner-centered alternatives to traditional instructional practices can have a significant impact on productivity in higher education. This article examines assumptions behind current practice and summarizes a roundtable discussion on higher-education supply and demand.

Twigg, Carol A. “Creating and Delivering Collegiate Learning Materials in a Distributed (Networked) Learning Environment: A Business Model for University-Corporate Collaboration.” Notes for the NLII-ITP Symposium on Creating and Delivering Collegiate Learning Materials in a Distributed (Networked) Learning Environment: A Business Model for University-Corporate Collaboration. 4–5 June 1997.

<http://www.educause.edu/nlii/nliiitpnotes.html>

Creating learning materials and using them in credit-bearing courses has four phases: content assembly, marketing and distribution, inclusion in the academic program, and certification of the learning results. For this process to succeed, we must create a new business model in a digital environment.

Twigg, Carol A. *Improving Learning and Reducing Costs: Lessons Learned from Round I of the Pew Grant Program in Course Redesign*. Troy, N.Y.: Center for Academic Transformation, Rensselaer Polytechnic Institute, 2003.

The Pew Grant Program in Course Redesign encourages colleges and universities to redesign their instructional approaches using technology to lower costs and enhance quality. In Round I, twenty institutions were invited to develop proposals. Class sizes for these projects averaged more than 1,000 students. Of the ten projects implemented, five reported improved learning outcomes. Four reported no significant difference, and one was inconclusive. By reducing the number of hours spent by faculty and others while keeping credit hours constant, all ten projects reduced costs (by an average of 33 percent) with no diminution of learning results. Seven kept student enrollments the same while reducing the instructional resources devoted to the courses. Three increased student enrollments but did not change course expenditure. Five showed a decrease in drop-failure-withdrawal rates, ranging from 10 to 20 percent. Projects used a number of techniques, including on-line course management systems; on-line assessment of exercises, quizzes, and tests; on-line tutorials; shared resources; and substitution of undergraduate learning assistants for faculty and graduate students. Success of these techniques depends on institutional readiness in several areas, including faculty willingness to collaborate; faculty consensus on desirable outcomes; faculty openness to change; faculty willingness to cede content choice to the team; institutional commitment to ubiquity of computing environment; learner readiness to engage in IT-based courses.

Twigg, Carol A. *Improving Learning and Reducing Costs: Redesigning Large-Enrollment Courses*. The Pew Learning and Technology Program invitational symposium on Redesigning More Productive Learning Environments. Roanoke, Virginia, 15–16 July 1999.

<http://www.center.rpi.edu/PewSym/mono1.html>

Using technology to redesign learning environments can enhance learning and reduce costs. This monograph includes four case studies illustrating successful practices.

Twigg, Carol A. *Innovations in Online Learning: Moving beyond No Significant Difference*. The Pew Learning and Technology Program. Troy, N.Y.: Center for Academic Transformation, Rensselaer Polytechnic Institute, 2001.

<http://www.center.rpi.edu/PewSym/mono4.html>

Participants in a December 2002 symposium in Phoenix, Arizona, considered how to move on-line learning beyond being “as good as” traditional education, and how information technology can be used to address the major challenges of higher education: improving quality, increasing access, and reducing costs. The participants concluded that individualization of student learning and standardization of faculty practice is the key to moving on-line education beyond the “no significant difference” phenomenon.

The monograph includes 13 short case studies of innovative practices in on-line learning.

Twigg, Carol A. “The Need for a National Learning Infrastructure.” *Educom Review* 29, 4, 5, 6 (1994).

<http://www.educause.edu/nlii/keydocs/monograph.html>

Higher education must create new ways of delivering higher education in response to changes in the way we define collegiate learning and to overcome the shortcomings of our one-size-fits-all approach to teaching.

Twigg, Carol A. *Quality Assurance for Whom? Providers and Consumers in Today’s Distributed Learning Environment*. The Pew Learning and Technology Program. Troy, N.Y.: Center for Academic Transformation, Rensselaer Polytechnic Institute, 2001.

<http://www.center.rpi.edu/PewSym/mono3.html>

Distributed learning presents problems for traditional quality-assurance practice, both from the perspective of institutions and agencies and from the point of view of consumers—primarily students, but also employers and graduate and professional schools.

Twigg, Carol A. *Redefining Community: Small Colleges in the Information Age*. The Pew Learning and Technology Program. Troy, N.Y.: Center for Academic Transformation, Rensselaer Polytechnic Institute, 2002.

<http://www.center.rpi.edu/PewSym/Mono5.html>

Information technology presents unique opportunities and challenges to small, residential liberal arts colleges. This study examines six new approaches being pioneered by peer institutions that are transferable to others.

Twigg, Carol A. *Who Owns Online Courses and Course Materials? Intellectual Property Policies for a New Learning Environment*. The Pew Learning and Technology Program. Troy, N.Y.: Center for Academic Transformation, Rensselaer Polytechnic Institute, 2000.

<http://www.center.rpi.edu/PewSym/mono2.html>

The production of on-line learning resources raises many policy questions. This study presents case studies illustrating the various dilemmas faced by institutions and establishes a conceptual framework to help institutions develop appropriate policies.

Twigg, Carol A., and Diana G. Oblinger. “The Virtual University.” A Report from a Joint Educom/IBM Roundtable, Washington, D.C. 5–6 November 1996.

<http://www.educause.edu/nlii/VU.html>

Because higher education will be different in the future, institutions must position themselves to participate successfully.

Additional information on the Web

Classroom Environment Committee: www.ncsu.edu/provost/governance/other_committees/CEC

Classroom-improvement requests: www.ncsu.edu/facilities/classrm/request.htm

ClassTech pilot project: www.ncsu.edu/it/classrooms/tour

College of Engineering's pilot laptop program: www.eos.ncsu.edu/soc/pilot.php

College of Veterinary Medicine's mobile computing initiative: www.cvm.ncsu.edu/mobilecomp

Computing labs: www.ncsu.edu/it/essentials/connections/campus_computer_labs/campus_labs.html

Copyright Use and Ownership Policy of the University of North Carolina:
www.northcarolina.edu/docs/legal/policymanual/500.2.pdf

Council on Undergraduate Education: www.ncsu.edu/provost/governance/standing_committees/CUEd

DELTA: delta.ncsu.edu

EDUCAUSE key themes: www.educause.edu/nlii/keythemes/eportfolios.asp

Facilities Planning and Design: www.ncsu.edu/facilities/fpd/home.htm

Faculty Center for Teaching and Learning (FCTL): www.ncsu.edu/fctl

Faculty Development Services: www.delta.ncsu.edu/lts/facdev/facdevbrochure.pdf

Gertrude Cox Award: zope.delta.ncsu.edu/gertrudecox

Help! FAQ tech support database: www.help.ncsu.edu

IDEA Grants: www.delta.ncsu.edu/ideagrants

Information Technology Division: www.ncsu.edu/it

Learning Technology Service (LTS): lts.ncsu.edu/index.cfm

LITRE home page: <http://litre.ncsu.edu/index.cfm>

Multimedia Users Group (MMUG): delta.ncsu.edu/lts/resources/programs/mmug.cfm

NC State Administrative Regulation for Copyright Implementation Pursuant to Copyright Use and Ownership Policy of the University of North Carolina:
www.ncsu.edu/policies/governance_admin/gov_gen/REG01.25.3.php

NC State courses database: www.courses.ncsu.edu

NC State design standards for classroom technology: www.ncsu.edu/facilities/univ-arch/const-guide.htm

NC State home page: www.ncsu.edu

NC State University Physical Master Plan: www.ncsu.edu/facilities/masterplan

NCSU Libraries: www.lib.ncsu.edu

NCSU Libraries Learning and Research Center for the Digital Age (LRCDA):
www.lib.ncsu.edu/administration/lrcda/index.html

NCSU Libraries Online Basic Orientation (LOBO): www.lib.ncsu.edu/lobo1/

NCSU Libraries Scholarly Communication Center: www.lib.ncsu.edu/scc

New student orientation: www.ncsu.edu/itfluency/upa_surveys.html#frosh

North Carolina Research and Education Network (NC-REN): www.ncren.net/InteractiveVideo

Online Student Portfolio Program: www.ist.psu.edu/portfolio/index.htm

Project 25: www.courses.ncsu.edu/info/f97_assessment.html#in

Report of the UNC Faculty Assembly regarding copyrights:
www.northcarolina.edu/content.php/facassembly/misc/iptf.htm

Software inventory: www.ncsu.edu/it/essentials/software

Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP):

www.scaleup.ncsu.edu

Survey of graduating seniors: www.ncsu.edu/itfluency/upa_surveys.html#snr

Survey of sophomores: www.ncsu.edu/itfluency/upa_surveys.html#soph

TEACH Act: www.lib.ncsu.edu/scc/legislative/teachkit

Teaching and Learning with Technology Roundtable (TLTR): www.ncsu.edu/tltr

Unity software applications: www.ncsu.edu/it/essentials/software

University Standing Committee on Copyrights:

www.ncsu.edu/ncsu/provost/info/governance/standing_committees/CopC

WebAssign: webassign.ncsu.edu

WebCT: webct.ncsu.edu

WolfWare: wolfware.ncsu.edu

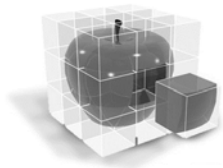


APPENDIX C

Student Information Fluency

Ensure that new students are prepared to meet technology-use expectations.*	For current students, integrate appropriate technology-enhanced learning with the core academic activities of the university.**	Ensure that graduates have appropriate technological proficiency and learning in their disciplines to allow them to succeed.
<p>Upon entering the university, all students should be able to:</p> <ul style="list-style-type: none"> • Employ electronic communication • Create electronic documents and visual presentations • Use electronic tools for research • Use databases to manage information • Use electronic tools for data analysis and visualization • Use hardware and operating system features • Determine the nature and extent of information needed to solve a problem • Locate and critically evaluate appropriate information resources • Identify a variety of types and formats of potential sources for information • Use information effectively to accomplish a purpose <p>Upon entering the university, all students should be familiar with the following concepts:</p> <ul style="list-style-type: none"> • The structure of a computer system (operating system, applications, file management, software vs. hardware, how viruses work, etc.) • How information systems work • Networking, that computer systems can connect to other computer systems (client vs. server) • How to determine which on-line resources to access for various types of information (e.g. library catalog vs. library databases) 	<p>Continuing students should develop independent software skills through the use of manuals, tutorials, and on-line resources and apply those skills to the work of the disciplines by:</p> <ul style="list-style-type: none"> • Researching information in the field through appropriate discipline-specific databases and search engines • Analyzing and manipulating discipline-based data in written, numerical, and/or visual form, using software that is compatible with industry standards in the field(s) • Explaining/illustrating key disciplinary concepts, theories, and/or research findings in written, visual, and oral presentations • Choosing appropriate applications for specific tasks by making critical evaluations of the “goodness of fit” between software capability and information goals • Digitally accessing and/or constructing footnotes, citations, bibliographies, and/or indices • Using information technology legally and ethically <p>Continuing students should engage with technology-mediated instructional support, such as:</p> <ul style="list-style-type: none"> • Distance education • On-line tutorials and help sites • In-class demonstrations • Classroom chat environments with faculty and/or other students • Discipline-specific databases, linked directly to course instruction (e.g. slide collections, audio collections, lab reporting Websites) • Library virtual reference assistance <p>Continuing students should collaborate on the work of the discipline with fellow students and faculty, and librarians through technology.</p> <p>Continuing students should develop skills in non-computing technology required to do the work of the disciplines (i.e. science labs, design studios, shops) for specific purposes, including:</p> <ul style="list-style-type: none"> • Conducting experiments • Developing prototypes or models that describe physical or abstract relationships • Determining the performance/behavior of materials, forces, or other physical phenomena • Inventing technology <p>Continuing students should develop means for documenting personal performance over time, including electronic portfolios, physical portfolios, and presentations.</p> <p>Continuing students should recognize when to consult with</p>	<p>When leaving the university, students should be able to:</p> <ul style="list-style-type: none"> • Use technologies required for entry-level employment in their chosen field • Identify information sources that are used by their chosen field • Use search mechanisms of information databases in their chosen field • Make intelligent choices among competing technologies in their chosen field • Maintain currency in technology applications through skills developed as students <p>In preparing applications for employment or further education, students should be able to:</p> <ul style="list-style-type: none"> • Use technology to compile summary presentations of knowledge and skills (e.g. electronic portfolios, digital resumes) • Approach the acquisition of new technology skills with confidence

	experts in the field/subject.	
* Technology for this group of students is limited to computers.	** Technology for this group of students is expanded to include more than computing. In some colleges this may mean science labs, wood and metal shops, industry-related machinery, graphic arts equipment, video and film equipment	



APPENDIX D

Sentence Summaries of Proposed LITRE Implementation Plans

Educational Infrastructure

Assessing “Best of the Best” Practices: University would form a “best practices” committee to identify universities and programs exploring innovation in learning workspaces, establish contacts, and schedule trips to assess programs.

Bluetooth-Enabled Classroom: University would build a wireless classroom designed for collaborative learning, using a combination of off-the-shelf technologies, including cell phones and PDAs equipped with Bluetooth, a wireless technology.

Broad-based Investment in Classrooms: University would launch and support several initiatives to encourage seamless integration of newly available technologies into classrooms, including updates to classroom technology standards; improvements to repair, maintenance, and upgrade procedures; hiring of support staff; and reforms to classroom scheduling.

Campuswide Calendaring System for Faculty and Students: Based on the recommendation of the University Information Technology Committee, the university would adopt a common calendaring system to serve the university’s multi-platform computing environment.

Classroom-Specific Software: G-108 HA Pilot: An ad hoc PAMS faculty committee would assess computer, software, networking, hardware, and support needs for courses in physics, chemistry and math taught in computer lab-classrooms where technology is tightly integrated with instruction and would recommend appropriate changes.

Delivering Software to COE Classes and Labs: The College of Engineering would develop a scalable and centralized support model for delivering discipline-specific software loads to specialized departmental computing laboratories from a central repository of licensed software binaries. This model would be implemented in a pilot project for a single department.

Digital Media Lab in LRCDA: LITRE would encourage the continued support of this workspace.

FlySpace: ITD would build a small meeting space located at a public lab facility. This space would be conducive to group projects or virtual collaboration.

Learning Management System: DELTA would develop a transition plan to move the university to a common learning management system.

Remote Access to Software: University would extend access to key software packages to faculty and staff working in off-campus locations.

Workspace lockers: WolfWare would incorporate the course workspace locker concept currently used by the COE through ITECS.

E-learning Environments

DE Preparedness: DELTA would develop two Web-based resources: course-level information for faculty, and program-level information for administrators, faculty, and staff.

DE Undergraduate Completion Program in CHASS: In partnership with UNC-Greensboro, CHASS would implement a DE undergraduate completion program culminating in a bachelor's degree in liberal arts and sciences with a concentration in leadership and public affairs.

DE Course Enrollment Policies and Strategies for Resident Students: To identify barriers to full incorporation of DE into the academic mainstream, DELTA would employ graduate students to research and analyze such factors as tuition, fee, and enrollment policies; academic funding models; infrastructure costs; enrollment patterns; and progress toward degree.

Faculty Engagement

Faculty Computing Initiative: University would implement an organized approach to supplying faculty with computers, based on Virginia Tech's Instructional Development Initiative. University would supply replacement computers to faculty every three years, provided that they participate in a workshop series which would acquaint them with their new equipment, update them on the campus technology infrastructure, and introduce new instructional technologies.

Faculty Development Programs in TLT: DELTA would continue to run the Summer Institute for Teaching and Learning with Technology, expand the Instructional Technology Assistant Program, and launch a new Faculty Instructional Technology Training program to help faculty teach and learn with technology.

Faculty IT Grants: DELTA would run a grants program to provide resources to faculty who wish to experiment with new teaching methods and technologies. Grants would support planning, design, and development of high-quality, technology-enhanced learning materials, learning technologies, courses, and programs.

Supporting Faculty through the Scholarship of Teaching: The Faculty Center for Teaching and Learning would launch a pilot of a review system for the scholarship of teaching and learning in a receptive department or college.

Learning Resources

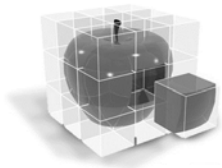
Copyright Policy for TLT: University would conduct an active review of copyright policy and procedures to remove disincentives to innovative work in teaching and learning with technology.

Student Information Fluency

Electronic Portfolios: University would support an electronic portfolio program for students.

GER Related to Technology: The Council on Undergraduate Education would appoint a subcommittee to recommend a new rationale and learning objectives for the Information and Computer Literacy GER.

Technology Tutors: The Division of Undergraduate Affairs and ITD would train tutors and supplemental instructors as special computing consultants to provide just-in-time support for students having difficulty with software functions.



APPENDIX E

Initiatives relating to LITRE in Compact Plans from Academic Affairs

Described below are initiatives focused on improving student learning through technology, which were submitted to the provost in first draft (round one) compact plans in fall 2003. Not all of these initiatives will be funded or included in final compact plans adopted mid-2004. The selection and description of these initiatives were made by University Planning and Analysis for use by the LITRE team.

College of Agriculture and Life Sciences

Expand Distance Education Courses and Programs: Encourage course development training; work collaboratively with departments and other institutions; market the DE program; and hire a director of distance education.

Improve Educational Infrastructure: Provide students with access to state-of-the-art equipment and technology for classrooms, laboratories, farms, and greenhouses, including the use of wireless technology, PDAs, improved telecommunications, and modern scientific and agricultural instrumentation.

College of Design

Nurture Digital Currency in All Phases of Operations and Instruction: Integrate new learning technologies into studio and course settings; assess computer needs, and Materials Laboratory needs such as the metal and wood shop, weaving, printing, and animation and rapid prototyping; and ensure regular upgrading and training.

College of Education

The William and Ida Friday Institute for Educational Innovation: Conduct research and extensive programs of professional development to ensure that North Carolina is well prepared educationally for the challenges of a global knowledge society, including innovative applications of instructional technology.

Develop a College Office of Distributed Learning Services: Increase dramatically distance and on-line course offerings. Expand and better support the Learning Technologies Resource Center staff with expertise in technology-enabled teaching, video production, graphic and instructional design, hardware reservation, media collections and duplication, and technical services.

Students Advocating for Youth and M.Ed. in Youth Development Leadership: Allow the master's students to serve as cyber-mentors to SAY students and others, utilizing the technological capabilities of Lee Hall, the College, and the Friday Institute.

Enhance Selected Doctoral Programs: Create a specialization in student affairs administration, moving towards technology enhanced and delivered student services.

College of Engineering

Engineering Design Center: Provide flexible space for design studios, a model shop, CAD resources, offices, and technology-rich classrooms with computers and audio-visuals accessible to students, faculty, staff and industrial sponsors.

Student-Owned Computing: Continue transition from lab computing to a student-owned computing environment for engineering students and negotiate special pricing on hardware and software to make it possible. This will lay foundation for a similar university-wide initiative.

College of Natural Resources

National Center for Geo-Spatial Sciences: Develop technological tools for geographic information systems (GIS) and remote sensing for use in the management of information through technological means, partnering with state, federal and private groups.

Learning in a Technology-Rich Environment: Continue leadership in incorporating advanced technology into classroom experiences by assuring the availability of technology-based teaching infrastructure, creating distance-education programming as a core instructional methodology, and educating our graduate students so that they will become leaders of technology-based learning.

College of Management

Center for E-Commerce @ NC State: Apply for official UNC center-status for the E-Commerce Center. In collaboration between CoM and Computer Science, the initiative supports MBA courses, research and teaching laboratories, close working relationships with major corporations, national conferences, visiting speakers, workshops, and faculty research awards.

Center for Entrepreneurship and Technology Innovation: Develop coordinating structure for programs and activities that focus on new product development and high-tech entrepreneurship.

College of Physical and Mathematical Sciences

Computer Testing Facility: Develop a large-scale computer examination facility using WebAssign. Homework and exams would be administered and graded on computers, increasing efficiency and freeing instructor time.

Extend SCALE-UP: Extend the Astudio learning@ format for courses with large enrollments from physics to chemistry and other departments. The SCALE-UP classrooms are equipped with laptops and projection tools that require technical support and maintenance.

Visualization and Intelligent Tutoring in Introductory Physics Instruction: Develop a physics curriculum in which students write computer programs and use Vpython 3D simulation to explore atomic-level models of matter, creating a foundation for work in nanotechnology, materials science, and computational science.

Expand On-Line and Distance Education: Expand on-line and distance education courses in every department of PAMS.

Technology Enhanced Instruction in the Mathematical Sciences: Incorporate technology more effectively in mathematical sciences classrooms, including lectures and discussion sessions, and assess the impact on student learning. This initiative requires appropriate classroom facilities, equipment and software.

College of Textiles

Develop Student Computer Skills Strategy: Develop a list of skills and software in which students must be proficient, and develop measures of computer literacy for students. Assist faculty in incorporating the skills into lesson plans.

Student-Owned Laptop Initiative: Require all incoming freshmen to have laptop computers and maintain laptops for student use. This requires the development of a wireless network to support multiple laptops in a single area, and assistance to faculty to develop materials and strategies to facilitate use of laptops in the classroom.

Extension Short Courses with Laptops: Expand strategy of laptop use in extension courses for facilitation of Internet access, sharing work and downloading needed materials.

Create New Lab Facilities: Construct new research and teaching laboratories in coordination with the Department of Biomedical Engineering. This includes design of new lab, acquiring equipment and increasing research funding.

Create New Studios: Create new studio facilities including traditional studio workspace and easy access to prototyping facilities and digital design and manufacturing tools.

College of Veterinary Medicine

Conduct Annual TAU Food Animal Forum: Expand instruction in live animal health by sharing access to TAU Website and Web cam for birthing instruction videos with other veterinary medicine colleges.

CVM PDA Initiative: Continue distributing PDAs to students in all classes and instructional faculty. This provides students with rapid access to information resources, increases active participation, and develops confidence in technology in veterinary practices.

Image Database: Implement several digital image management systems to allow retrieval and sharing of still, movie, and sound images. This effort will include a digital-image database manager.

Adult Credit Programs

Development and Delivery of Noncredit Distance Education Courses: Develop a distance education non-credit continuing education plan to better respond to corporate training needs, and establish NC State as a leader in technological and scientific distance and continuing education programs.

Develop Interactive and Customer-Service Focused Websites and Web-based Instructional Options: The Credit Programs and Summer School unit, working with other units will enhance the delivery of internet-based student services to facilitate access to programs at NC State.

Distance Education and Learning Technology Applications

Provide a Web-based Center of Student Academic Services: Research portal products and define migration paths for campuswide academic portal solutions to allow students greater access to learning support resources.

Promote Distance Education Preparedness: Provide information to faculty on quality, delivery mechanisms, procedures, and services available for development of distance education courses and programs.

Provide Enterprise-Level Instructional Tools for Teaching and Learning: Develop an enterprise learning management system transition plan for providing targeted instructional tools and support for developing effective technology-rich learning environments that meet all learning styles and teaching methods.

Support the Use of Wireless Technologies in Teaching and Learning: Create a handheld-computing team to promote appropriate use of wireless technologies. Support the move to wireless technologies by offering workshops, and hands-on training. Work with the WebAssign team to develop wireless assessment methodologies.

Expand Faculty Development Programs in Support of Teaching and Learning with Rich Technologies: Expand opportunities for students in programs such as the Summer Institute, the Instructional Technology Assistant Program, and the Faculty Instructional Technology Training Program.

Study of Distance Education Course Tuition Structure, Student Course Load and Residency Distance Education Students: Form an advisory committee to review policies related to tuition, residency requirements for graduate students, course load calculation for students taking on-and off-campus courses, and financial aid for distance education students.

Improve Faculty Engagement with Instructional Technology: Offer services in support of teaching and learning with technology, including providing workshop offerings outside of NC State; providing reports of LTS activities; studying the impact of the Summer Institute and Instructional Technology Assistant Program; and improving faculty development services in conjunction with the NCSU Libraries.

Promote and Sustain New, Innovative and Strategic Distributed Learning Instruction for NC State: Improve the grant distribution process by creating an on-line RFP submission tool, creating and maintaining an electronic project database, promoting a systematic proposal review, offering grant workshops, providing best

practices resources, revising project timelines, using assessment to improve efficiency, and improving DELTA visibility.

Enrollment Management and Services

Computing Initiatives to Improve Service and Access to Information: Use Web inquiries and e-mail to make financial aid information accessible on-line to students and campus administrators; create bi-monthly admission status reports; and maintain adequate dedicated to financial aid systems processing and enhancements.

Develop Software in Support of the Progress toward Undergraduate Degree Policy Continue to develop the Undergraduate Plan of Work and assist ACS to develop programming to enforce the Progress toward the Undergraduate Degree Policy.

Faculty Center for Teaching and Learning

Provide Workshops: The essential role will be to provide strengths in the use of technology for teaching, and provide leadership for the LITRE plan, ensuring that it is faculty driven.

Inquiry-Guided Learning at NC State On-Line: Provide a portal for the inquiry-guided learning efforts on campus, and articulate a vision for the transformation of undergraduate education at NC State through inquiry-guided learning. This effort includes development of a new Website that will be used to deliver inquiry-guided learning materials.

Graduate School

New On-Campus Graduate Degree Programs: Facilitate development of inter-institutional degree programs by use of distance technology.

Distance Education Graduate Programs: Make distance education an integral part of instructional strategies by integrating distance learning with other delivery systems, maintaining quality equal to on-campus instruction and providing adequate support for faculty developing new technologies for delivery.

Information Technology Division

Integrated Collaborative Technology and Assessment Project: Explore inter-project technology integration, management, and assessment efforts that would eventually result in an audit of centrally supported technology services and resources for support of LITRE.

Information Technology Fluency Initiative—Tutorial Center / ITD Collaboration Pilot Proposal: Develop a computer consulting/tutorial services pilot project to assist students competency in computing skills.

Wireless Data Connectivity Build-out and Wireless Service Delivery: Supplement and expand current wired infrastructure to provide additional network connectivity to meet the needs of a mobile campus population; focusing first on student needs, then expanding to serve faculty and staff needs in a five-year implementation plan.

Mobile Computing Systems, Applications and Support: Design and implement a coherent mobile computing and learning environment by providing training for faculty on instructional use of wireless technologies, and offering strategic services for students.

Advanced Remote Access Services and Virtual Computing Lab Pilot Project: Offer remote access to services and software applications students need for success in their disciplines, as an alternative to on-campus computer labs.

Central Support Service for Multimedia Classrooms Pilot Project: Create a centralized plan to implement and maintain new multimedia classrooms, in answer to faculty requests for greater technology resources in the standard classrooms.

Research and High Performance Computing Initiative: Build on-campus high performance computing (HPC) capacities, expertise, and support structures; develop regional networking infrastructure; and provide North Carolina researchers with access to national supercomputing centers.

International Affairs

Technology-Enhanced Information Systems: Assist international students in acquiring information about requirements, policies and practices, resources and opportunities using searchable delivery systems; and bring a satellite-based multi-lingual global news network to campus.

Model International Engineering Program: Create semester-length program models to attract engineering students, and attract sufficient numbers of students to make the program self-supporting.

NCSU Libraries

Student Learning in a Technology-Rich Environment: Offer physical facilities, tools, resources, and instructional activities in which librarians assist students and faculty to acquire and develop critical information skills.

Office of Equal Opportunity

Course Content Accessibility Response Team: Create a mechanism to rapidly assess media accommodation needs, and to devise solutions to affect accommodation of special needs as outlined by Disability Services for Students (DSS).

Accessible IT Production and Research Support Facility: Establish a facility that will work to improve the efficiency and quality of the production of accessible multimedia alternate format materials; and provide support and education on DSS technology issues.



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