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Introduction

The purpose of any benchmarking project is to address three fundamental questions:

- Where are we now?
- Where do we want to go?
- How do we get there?

The University of North Dakota (UND) identified Information Technology (IT) literacy of undergraduate students as an area requiring a benchmarking study. UND believes this topic to be important for several reasons.

Since 1996, there has been a trend for institutions of higher education to aggressively explore the use of computers and the Internet in the teaching and learning process and overall college experience. The reasoning behind this focus is the ever-growing integration of technology into society. There are many examples of this in the sciences, medicine, and business and industry as one would expect. However, technology has also permeated daily life, in the most common ways. In the March 11, 2003 posting of USA Today Web Guide, the headline reads, “McDonald’s to serve up wireless Internet access” (March 11, 2003. http://www.usatoday.com/tech/webguide/internetlife/2003-3-11-mcdonalds-net_x.htm#). Another example is from eWeek, August 21, 2002, announcing that “Starbucks serves up wireless Internet access” (Nobel, C. August 21, 2002. http://www.eweek.com/article2/0,3959,478879,00.asp). This pervasiveness of information technology assumes a certain level of interest and skill proficiency among Americans that did not exist ten years ago.

Today, traditional age college students use the Internet as a part of their daily routine. They have been exposed to information technology all of their lives. “Internet use is so normalized in America that even most non-users say they are in close proximity to the Internet. They either have friends or family who use the Internet or they know of public access locations in their communities” (Lenhart, A., April 16, 2003, Summary of Findings, http://www.pewinternet.org/reports/reports.asp?Report=88&Section=ReportLevel1&Field=Level1ID&ID=378). Technology has become as ordinary as the telephone or television. Approximately 72% of college students check their email at least once per day with 85% owning a computer while attending college. While half (49%) began using a computer when they arrived at college; half (47%) began using the Internet while in high school (Jones, S., September 15, 2002, Summary of Findings, http://www.pewinternet.org/reports/reports.asp?Report=71&Section=ReportLevel1&Field=Level1ID&ID=312).

The 2000 Pew Internet and American Life Project Teens and Parents Survey results show that 98% of American public schools have some kind of Internet access for students and that online access is utilized. In addition, the Pew Internet and American Life project reports that 53% of adult Internet users have accessed the Internet to do research for school or job training and 52% have conducted job-related research online (Lenhart, A., Simon, M., & Graziano, M., September 1, 2001, p. 2, (http://www.pewinternet.org/reports/chart.asp?img=19_schooluse.jpg)
Our economy depends on technology to provide a means of communication to and an exchange of knowledge with consumers and businesses regardless of time and place. Email is becoming an accepted, and in some cases a preferred form of communication. It is prevalent in the workplace as well as on the university campus. Pew reports that 62% of Americans have Internet access and 98% of them use email on the job (Fallows, 2002, http://www.pewinternet.org/reports/reports.asp?Report=79&Section=ReportLevel1&Field=Level1ID&ID=346). It is predicted that knowledge sharing in education, corporations, and government as well as associations and non-profits, will be “substantially reinvented” through digital technologies by the year 2010 (Transforming e-Knowledge, 2003, p. V).

In addition to the above, EDUCAUSE (http://www.educause.edu/consumerguide/) includes results from the Campus Computing Project 2002 showing the percentage of schools that have a computer competency requirement for all undergraduates. The chart below provides detail.

Source: http://www.educause.edu/consumerguide/academic.asp#

Hence, recognizing that being able to function in a digital world is rapidly becoming a requirement for success both at the university and the workplace, UND seeks to identify what measures, if any, should be undertaken in the area of student IT literacy skills, knowledge, and attitudes.

**Scope of the Report**

The University of North Dakota (UND) contracted with Collegis, Inc. in Spring 2003 to conduct a benchmarking study in the area of student information technology (IT) literacy specifically addressing the issues of

- Information Technology skills, knowledge, and attitudes upon entrance to the University
• Assessment of IT skills, knowledge, and attitude upon entrance
• Remediation of IT skills, knowledge, and attitude when found deficient
• Information Technology skills, knowledge, and attitudes upon graduation from the University
• Assessment of IT skills, knowledge, and attitude upon graduation

Methodology

Data for this benchmarking study was collected by a Collegis Senior Consultant from a variety of sources both in person and via electronic communication.

1. Three-day site visit to the University of North Dakota.
   • Meetings and interviews
     o UND project directors, James Shaeffer, Dean of Outreach Programs and Interim CIO and Dorette Kerian, Director of Information Technology Systems and Services (ITSS) to confirm goals and timelines for the engagement.
     o Key stakeholders in the project representing the following departments or committees were interviewed.
       ▪ IT Literacy Committee
       ▪ Center for Institutional and Learning Technologies (CILT)
       ▪ Aerospace
       ▪ Outreach
       ▪ ITSS Help Desk
       ▪ Library
       ▪ Medical School
       ▪ Law School
       ▪ Students
     • A tour of library, CILT, Nursing

2. A UND survey distributed to 74 department heads (approximately 50% return rate) identifying entry IT skills for new students, IT exit competencies expected of graduates upon completion of degree program, and remediation interventions.

3. Recommended guidelines from organizations and agencies (national and state)

4. Effective practices models from other higher education institutions

5. Student IT literacy practices at peer institutions as identified by UND
   • Ohio University - Main Campus
   • Southern Illinois University – Carbondale*
   • SUNY at Buffalo*
   • University of Louisville
   • University of Missouri-Kansas City

After all data was collected, University of North Dakota information was compared to that of peer institutions, institutions with student IT literacy requirements and considered as effective practice models, and guidelines from organizations and agencies. Recommendations were then developed to assist UND in formulating an IT literacy program specific to the needs of the University.

*Responding institutions
Report Organization

An Executive Summary describes briefly the salient findings of the research and lists the recommended IT literacy skills, knowledge, and attitudes found to be common among all sources of information. A statement of Institutional Context as it relates to student information technology literacy at UND begins the main body of this report and gives a framework for this study in relationship to the alignment with the UND strategic plan and other initiatives. The term, “student information technology literacy,” is then defined to provide a scope for the information that is to come. A literature and research review that includes guidelines or requirements by national and state organizations, competencies recommended for high school graduates, competencies required or suggested for graduate school admissions, and employer expectations are followed by effective practices from other institutions and information obtained from UND peer institutions.

Findings and recommendations pertaining to each benchmarking category follows. These are based on the interview and focus group information obtained during the three-day UND campus visit and the information from the literature and research review. Implications of this benchmarking study complete the main body of this report. The remaining sections are the appendices containing the results of the UND student IT entry and exit skills survey, comparison table of peer institutions by item, the July 2002 freshman survey results from the State University of New York – Buffalo, and the report references.
Executive Summary

Information Technology literacy has evolved from computer literacy with a narrow skills connotation to a much broader definition. In addition to skills, IT literacy also includes knowledge of Web/Internet and database search techniques and validity of located information plus networks, connectivity, email etiquette, and security. Attitudes associated with ethical use of information and intellectual property complete the definition.

In partial implementation of the institutional action strategies concerning student IT literacy, the University Information Technology Council (UITC) distributed a departmental survey of IT entry and exit competencies during the Fall 2001. The results of that survey indicate that desired entry-level IT skills currently identified by departments align with a number of discipline-specific courses already in place to remediate and reinforce skill levels. Interviews conducted during Spring 2003 validated survey results plus provided insight and more detailed information as to what interviewees believed to be important IT literacy skills, knowledge, and attitudes. Help Desk reports validated interviewee and survey respondent comments.

National organizations and high school IT competency standards, graduate school entrance requirements, and employer expectations as well as a representative sampling of colleges and universities that currently have implemented some form of undergraduate IT literacy requirement were compiled. Included in this review, was the peer institution information obtained from the State University of New York (SUNY) – Buffalo and Southern Illinois University (SIU) – Carbondale. Of the five peer institutions identified by the University of North Dakota, only two responded to the request for information concerning student IT literacy.

Results of this research were compared with UND data to produce the list of student IT literacy skills, knowledge, and attitudes below. This list is the major recommendation of this report. The depth of proficiency in each will need to be defined by each discipline; however, a basic proficiency level should be determined by the university as a whole.

Recommended Student Information Technology Literacy

Skills:
- Word processing
- Operating system tools
- Email
- Access to and location of information on the Web/Internet and Library databases
- Search strategies
- Spreadsheets
- Presentation software
- Basic troubleshooting

Knowledge:
- Validity of data obtained electronically
- Copyright and intellectual property
- Security
- Implications of electronic communication and transmission of information

Attitudes:
- Ethical use of information
- Privacy
- Electronic communication etiquette
Institutional Context

The University of North Dakota has identified information technology as a vital component of future success. The University has undertaken a number of measures to address the role that IT plays in teaching and learning, research, and business practices of the institution. First, UND has identified technology as one of the priority/action areas in the 2001 strategic plan.

**F. Optimize the use of information technology to improve student learning, research, and the administration of the University**

The campus must have up-to-date equipment and resources in the area of information technology. Technology can enhance student learning by providing additional opportunities for interactive learning and greater access to higher education. Distance learning technology will serve to eliminate geographic boundaries. UND strives to be at the cutting edge of technological applications in learning and research. Technology will also enhance the University's operational efficiency.

UND also believes that technology can extend its reach to students, faculty, and communities beyond the local community and state to those located globally. In the section of the strategic plan entitled, POSITIONING OF THE UNIVERSITY, the importance of being technologically current is emphasized.

The University employs state-of-the-art technology to enrich and extend learning opportunities to people throughout the world.

Additionally, Blackboard has been established as a course management system providing faculty a means to integrate technology into the classroom experience. Through goals, objectives, and activities, the UND IT plan for FY 2003 addresses technology infrastructure, educational information systems, and technology support for learning and research. The goals, objectives, and action items of the Center for Instructional and Learning Technologies align directly with the institutional priority/action area relating to information technology.

Given the focus on incorporating information technology into university life, it is not surprising that two of the university-wide action strategies, address student information technology literacy proficiency.

- Define necessary entry-level computer competency for all new students, designing screening and assessment techniques and remedial “courses” as appropriate. (CIO, UITC/AY ’02)

- Ask all departments to define “exit” competencies of graduate in the use of computer and information technology. (VPA/AY ’02) ED5

In accomplishment of these action strategies, the University Information Technology Council established a sub-council, the Student IT Literacy Committee, under the leadership of Tom Wiggens and Deb Glennen. The committee developed a Departmental Survey of IT Entry and Exit Competencies distributed it in September 2001 to 74 department heads with 25 returns (see Appendix A).
The University of North Dakota is not alone in asking these questions and seeking to determine how best to serve students given the ever-increasing role of technology in education. “Institutions – large and small, public an private, general and specialized – are trying to determine how much students need to know about computers before they arrive on campus, how much they must know to graduate and how best to deliver that knowledge. So far, there’s no single standard. Expectations vary among schools and programs and shift with each new wave of technology and with cuts in resources. But few educators dispute that, for today’s college graduates, familiarity with computers is rapidly becoming as important as knowing how to read and write” (Stuart, A., January 3, 1996, http://www.annestuartonline.com/BHMDegrees.htm).

**Student IT Literacy – A definition**

A beginning point for addressing student IT literacy is to define what is meant by the term and why it is important. Information technology has evolved from computer literacy, a term coined by Andrew Molnar, while serving as director of the Office of Computing Activities at the National Science Foundation. “We started computer literacy in ’72 […] We coined that phrase. It's sort of ironic. Nobody knows what computer literacy is. Nobody can define it. And the reason we selected [it] was because nobody could define it, and […] it was a broad enough term that you could get all of these programs together under one roof” (FOLDOC, September 7, 1998. http://wombat.doc.ic.ac.uk/foldoc/foldoc.cgi?computer+literacy). Computer literacy from the beginning was meant to be a descriptor that allowed for flexibility in computer technology. It focused on the “basic skill in use of computers, from the perspective of such skill being a necessary societal skill” (Ibid).

In an article by Morgan (1998, http://www.infomotions.com/musings/computer-literacy/), computer literacy is described as “taking control of your computer and not letting it control you. You are computer literate when you feel you are telling the computer what to do and not the other way around. It’s the ability to manage the relentless bits and bytes flooding your electronic desktop on a regular basis. It’s the ability to systematically – yet flexibly – communicate this management process to other people. Its not necessarily knowing what button to push, but it is knowing the difference between a word processor and a text editor, a spreadsheet and a database program, or a local disk drive and a networked file server.”

Today, computer literacy has evolved to information technology literacy and according to a study and subsequent report by the National Academy of Sciences, is more accurately described as information technology fluency. The definition goes beyond compensating for the diversity in computer technology and skill level. Information technology fluency encompasses

- Intellectual capabilities or the ability to apply information technology in complex and sustained situations
- Foundational concepts or the basic principles and ideas of computers, networks, and information, and
- Contemporary skills or the ability to use today’s computer applications.

Fluency with information technology “requires that persons understand information technology broadly enough to be able to apply it productively at work and in their everyday lives, to recognize when information technology would assist or impede the achievement of a goal, and to continually adapt to the changes in and advancement of information technology” (Being Fluent with Information Technology, 1999, http://stills.nap.edu/html/beingfluent/es.html).
The National Academy of Sciences also believes that being IT literate is important. There are four categories of rationale motivating individuals to become information technology literate. These are “personal, grounded in our digital lifestyle and daily exposure to technology and technology innovations; workforce, with our society becoming increasingly more global and more e-commerce dependent; educational, providing opportunities through technology that were impossible prior to the digital age; and societal, having access to information concerning public policy debates and local, national, and world issues” (Ibid).

IT literacy is also closely linked to information literacy. According to the Association of College and Research Libraries, individuals who are information literate are able to “recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information. Information literate individuals necessarily develop some technology skills and, increasingly, information technology skills are interwoven with, and support, information literacy” (Association of College and Research Libraries, 2000, p. 2-3, http://www.ala.org/Content/NavigationMenu/ACRL/Standards_and_Guidelines/standards.pdf).

When the University of North Dakota surveyed department heads concerning IT entry and exit competencies of undergraduate students, those competencies encompassed more than skills alone. They included knowledge of the ethical use of computers, copyright law, and privacy issues as well as word processing, web browser, and email skills. Thus, UND joins with others in defining IT literacy as a combination of IT skills and information literacy.

Literature and Research Review

Organizational Guidelines and Recommendations

For the purposes of this report, four organizations have been identified as having guidelines or recommendations for information technology literacy skills, knowledge, and attitudes. RAND is a non-profit institution that does research and analysis for the purpose of improving policy and decision-making. The National Academy of Sciences is a consortium of the Committee on Information Technology Literacy, Computer Science and Telecommunications Board, Commission on Physical Sciences, Mathematics, and Applications, and the National Research Council. EDUCAUSE is the third organization with the mission to advance higher education by promoting the intelligent use of information technology. Also, Blackboard was contacted to ascertain which skills are considered necessary for students to be successful.

Anderson and Bikson in a report written for RAND entitled, “Focus on Generic Skills for Information Technology Literacy” (January 14-15, 1998, http://www.rand.org/publications/P/P8018/) identify component knowledge of IT literacy. They suggest the following:

Connectivity is knowing if the computing device being used is connected to other sites and also includes an awareness of the information exchanged between the specified device and other devices. Security and privacy issues are included in this category (Ibid, p. 2).

Logic is described as the “fundamental constructs by which computers ‘decide’ what actions to take.” This knowledge is considered important because users need to be aware that computers do what the user asks – no more; no less. Information provided by the computer is not necessarily reliable, accurate, or validated (Ibid, p. 2).
The structuring of data and information refers to ways data “can be structured and stored.” The example given by Anderson and Bikson is the “smart card” that many institutions have adopted. “Is the card in my wallet that ‘contains’ digital cash a readable and writable nonvolatile storage device? If so, who can read? Who can write? Under what conditions? Is there a backup archive if the card becomes corrupted? And so on” (Ibid, p. 3).

Generic tools are those which are common across applications. Examples include spelling and grammar checks, a search engine either within an application or on the Web, and a filtering system for email or web pages (Ibid, p. 3).

Media includes digital sound, images, text, numbers, graphics or combinations of these and the implications of these media in “communication, computation, video, and audio” (Ibid, p. 3).

Interfaces are becoming more intuitive and transparent but until this has been achieved fully for all applications and access, it is important for the IT literate person to know “the basic ways that interfaces permit users to interactively guide computer programs plus common options for tailoring those interactions” (Ibid, p. 3).

Anderson and Bikson also suggest that the above components of IT literacy are missing two elements that go beyond skills and knowledge. These are the “social values” that give context to the skills and knowledge and are the “cornerstones of user literacy.”

Ethics and etiquette can range from “simple guidelines on using new forms of communication to more fundamental ethical questions of appropriate access to, and treatment and dissemination of, information” (Ibid, p. 4).

Rights and responsibilities refer to the single user in a broader context of local, national, and global communication and information access. “What are a citizen’s responsibilities and rights in cyberspace, with respect especially to privacy, anonymity, disclosure, intellectual property and other aspects of its governance?” (Ibid, p. 4).

Another nationally recognized organization is the National Academy of Sciences (NAS). NAS describes information technology literacy in terms of fluency. To acquire skills without “fundamental concepts and intellectual capabilities” only addresses the short term. Thus, a broad scope is suggested which includes the following elements.

Engage in sustained reasoning – The ability to define and clarify a problem when encountered or the ability to design a complete project that includes a number of different applications over time allows the user to “implement a solution” (http://stills.nap.edu/html/beingfluent/ch2.html).

Managing complexity – Each project or problem involving a computer has a degree of complexity to it. “A person needs to be able to plan a project, design a solution, integrate the components, respond to expected interactions, and diagnose what is needed from each task... Another source of complexity is the need to manage the resources that technology provides... A third source of complexity is the fact that large information technology-based systems often have interdependencies” (Ibid).

Test a solution – The ability to think about the end result and if the anticipated solution will meet the criteria is considered necessary for a person who is information technology fluent.
This then will allow for adjustments in the design of the project so as to better meet final objectives (Ibid).

Manage problems in faulty solutions – Troubleshooting everyday technology is needed to operate effectively in today’s environment. An example would be printing a document from a word processing application and the document does not print. There are a number of reasons why this occurs, from the printer not being plugged into an electrical outlet to the wrong driver being selected or actual equipment malfunctions. “A user needs to recognize that this is a solvable problem, find the broken link in the chain, and either solve the problem or call the appropriate expert” (Ibid).

Organize and navigate information structures and evaluate information – Finding information and evaluating it are necessary for computer applications users as well as those who access the Internet/Web. Locating and using online help and conducting Web searches are part of daily operation. A user should be able to access online help information, locate what is needed, and follow the instructions. In addition, “an individual must [also] be prepared to evaluate the reliability of a source, understand the nature of a shared information space such as the Web, and regard with appropriate caution the quality of the information retrieved” (Ibid).

Collaborate – The technology available today can assist groups of users to work together. In the absence of face-to-face interaction, the user must learn “how to cope with the limitations of technologically mediated interactions” (Ibid).

Communicate to other audiences – With global communication being the norm and the information technology capabilities being that they are, communication extends beyond words alone. “Effective communication requires familiarity with and understanding of the pros and cons of various means of communication, because the intervening technology may change the nature of the communication” (Ibid).

Expect the unexpected – Often an unexpected use of a technology system occurs that was not part of the original intent or design. For example the predecessor of the Internet, ARPANET, was intended to “facilitate the use of computers many miles away from one’s desktop” which is quite different from how we use the Internet of today. Another example is “making Web browsers in school libraries available to all students… to give students easy access to the rich information content of the Internet [also] may unintentionally expose students to child molesters, hate speech, and pornography” (Ibid).

Anticipate changing technologies – Technology changes rapidly and with these changes it is necessary for users to be able to adapt to new systems and new ways of performing tasks. Information fluency “entails the capability to adapt to new technology efficiently and how to learn a new language or system, building on what is already known about older, perhaps similar technologies and facilities” (Ibid).

Think about information technology abstractly – How technology should be applied to meet needs is another mark of the information technology fluent person. The ability to “transfer the principles of technological solutions from one setting to another; recognize technological analogies, and use them to become adept with new technology quickly; have high expectations for technological solutions; and find work-arounds when technology falls short” are all necessary capabilities for the technologically fluent user (Ibid).
With the rapid changes in technology occurring daily, it is necessary to be able to update skills easily. To do this, an understanding of a “few basic ideas and concepts underpinning information technology” is necessary. The concepts listed below are not in order of importance.

1. Computers – Key aspects of a stored-program computer - “Computers do what the program tells them to do given particular input, and if a computer exhibits a particular capability, it is because someone figured out how to break the task into a sequence of basic steps, i.e., how to program it.
   a. The program as a sequence of steps
   b. The process of program interpretation,
   c. The memory as a repository for program and data, and
   d. Overall organization, including relationship to peripheral devices, e.g. I/O devices” (Ibid).

2. Information systems – The general structural features of an information system

3. Networks – “How computers can be connected to each other and to networks, and how information is routed between computers” (Ibid).

4. Digital representation of information – The general concept of encoding information in binary form and that this is a “uniform way for computers and communication systems to store and transmit all information” (Ibid).

5. Information organization - Knowing the “general concepts of information organization, searching and retrieving, assessing information quality, authoring and presentation, and citation” (Ibid) are paramount to being computer fluent.

6. Modeling and abstraction – Distinguishing model from reality can be sometimes difficult. Recognizing the difference between computer applications that simulate the “crash of a sports car by abstracting real-work phenomena and manipulating those abstractions using transformations that duplicate or approximate the real-world processes” is needed. “Not all aspects of the real world are modeled in any one program, and a model is not reality” should be realized by users today” (Ibid).

7. Algorithmic thinking and programming – A basic concept of how and why information technology systems work as they do is needed when troubleshooting a problem. The recognition of proper operation or behavior of a system allows for easier determination of what is wrong or how a problem can be solved.

8. Universality – “Any computational task can be performed by any computer [and] computers differ by how quickly they solve a problem, not whether they can solve the problem” are a basic tenants of IT fluency. This distinguishes computers from other types of machines” (Ibid).

9. Limitations - “Computers possess no intuition, creativity, imagination, or magic... because the programs that run on computers are designed by human beings, they reflect the assumptions that their designers build into them, assumptions that may be inappropriate or wrong...Assessing what information technology can be applied – and when it should be applied – is essential in today’s information age” (Ibid).

10. Societal impact of information and information technology – Issues concerning “privacy, intellectual property, ownership, and security” have been the subject of much discussion since the beginnings of the Internet and Web. “Consider, for example, intellectual property. Copyright is accompanied by a well-established body of law, but now that the Web makes images and documents available to a huge audience, it has become much more important for Web users to understand that the ability to see an image on the Web does not automatically imply that the image can be copied or reused” (Ibid).

Information technology skills are usually associated with computer literacy, however, a set of skills is necessary for the applications that support the broader fluency requirements. The list
below of the ten essential skills focuses on “what one would need to know to buy a personal computer, set it up, use the principle software that comes with it, subscribe to an Internet service provider, and use its services.”

1. Setting up a personal computer
2. Using basic operating system features
3. Using a word processor to create a text document
4. Using a graphics and/or artwork package to create illustrations, slides, or other image-based expressions of ideas
5. Connecting a computer to a network
6. Using the Internet to find information and resources
7. Using a computer to communicate with others
8. Using a spreadsheet to model simple processes or financial tables
9. Using a database system to set-up and access useful information
10. Using instructional materials to learn how to use new applications or features

EDUCAUSE, another recognized authority, has developed a Consumers Guide in Evaluating Information Technology on Campus (http://www.educause.edu/consumerguide/). The Guide is designed to assist prospective students and their parents in selecting a college or university that matches student “educational and social needs and financial capabilities with the resources available at the colleges and universities.”

The Guide states that “information technologies are pervasive and are being woven throughout the fabric of our daily lives. Basic skills with computers, networks, and electronic information resources are expected in virtually all academic disciplines… Basic literacy with the technology tools of the modern office, library, school, or other place of work is now as important to your future as the other skills of critical thinking and analysis that higher education will offer you.”

The Guide suggests that students gauge to what degree institutions promote the following skills before selecting a college or university.

- The ability to engage in electronic collaboration;
- The ability to use and create structured electronic documents;
- The ability to do technology-enhanced presentations;
- The ability to use appropriate electronic tools for research and evaluation;
- The ability to use spreadsheets and databases;
- The ability to use electronic tools for analyzing quantitative and qualitative data;
- Familiarity with major ethical, legal, and security issues in information technology;
- Working knowledge of the dominant hardware, software, Web browsers, networks, file storage, and directory structures.

Since the University of North Dakota employs Blackboard as a course management system, the company was contacted requesting IT skills that were requisite or preferred for student users. The response received was the use of a mouse and ability to access the Internet.

**High School IT Competencies**

One way to determine appropriate IT literacy skills, knowledge, and attitudes for incoming students to the University of North Dakota is to review the competencies required of high school graduates. Hence, a search for standards or graduation requirements was conducted.
The American Association of School Librarians and Association for Educational Communications and Technology have published a list of standards that align closely with the various aspects of information technology fluency as described by Anderson and Bikson and the National Academy of Sciences. Many of these standards have information technology embedded within the process of demonstrating the competencies embedded in this set of standards (American Library Association and Association for Educational Communications and Technology, 1998, http://cnets.iste.org/currstands/cstands-il.html).

**INFORMATION LITERACY**
Standard 1: The student who is information literate accesses information efficiently and effectively.
Standard 2: The student who is information literate evaluates information critically and competently.
Standard 3: The student who is information literate uses information accurately and creatively.

**SOCIAL RESPONSIBILITY**
Standard 7: The student who contributes positively to the learning community and to society is information literate and recognizes the importance of information to a democratic society.
Standard 8: The student who contributes positively to the learning community and to society is information literate and practices ethical behavior in regard to information and information technology.
Standard 9: The student who contributes positively to the learning community and to society is information literate and participates effectively in groups to pursue and generate information.

The Georgia Library Media Association and the Georgia Department of Education have developed a set of information literacy skills for elementary, middle, and high school levels. The grades 9-12 skills checklist (http://www2.fultonschools.org/dept/medsvcs/HS-literacy.htm) includes both information and information technology skills.

**High School Literacy Skills Checklist**
The student will
- Log on to Internet to locate sources of information.
- Use search engines to locate sources of information.
- Evaluate web sites for accuracy of information (reliability, credibility, accuracy).
- Use GALILEO [database] as a source of information for research projects and personal information.
- Know the difference between online sources and Internet sources.
- Know how to create citations/ bibliographies for both print and non-print sources.
- Understand the ethics of using resources including copyright restrictions and the concept of plagiarism.
- How to use periodical indices. From the citations students will be able to identify author, title, publisher, copyright dates, etc…
- Use a variety of indices.
- Use OPACs to located resources in a library media center.
- Understand the Dewey classification system.
- Differentiate the strengths of different formats (Internet sources vs. print sources) and determine the resource most appropriate to their needs.
• Employ appropriate research strategies.
• Work independently and respectful of the rights of all patrons in the media center.
• Print information from the Internet efficiently.
• Use specialized dictionaries.

The Wisconsin Department of Public Instruction defines information and technology literacy as “the ability of an individual, working independently or with others, to use tools, resources, processes, and systems responsibly to access and evaluate information in any medium, and to use that information to solve problems, communicate clearly, make informed decisions, and construct new knowledge, products, or systems” (http://www.dpi.state.wi.us/dltc/imt/itlstfst.html).

There are four standards: the first two focus on technology use and information processing skills; the second two address the attitudes, appreciation, independent learning, teamwork skills, and personal and social responsibility associated with the previous ones. The standards statements are listed below.

**Twelfth Grade Performance Standards**

**Media and Technology-**
By the end of grade twelve, students will:

A.12.1 Use common media and technology terminology and equipment
A.12.2 Identify and use common media formats
A.12.3 Use a computer and productivity software to organize and create information
A.12.4 Use a computer and communications software to access and transmit information
A.12.5 Use media and technology to create and present information
A.12.6 Evaluate the use of media and technology in a production or presentation

**Information and Inquiry-**
By the end of grade twelve, students will:

B.12.1 Define the need for information
B.12.2 Develop information seeking strategies
B.12.3 Locate and access information sources
B.12.4 Evaluate and select information from a variety of print, non-print, and electronic formats
B.12.5 Record and organize information
B.12.6 Interpret and use information to solve the problem or answer the question
B.12.7 Communicate the results of research and inquiry in an appropriate format
B.12.8 Evaluate the information product and process

**Learning Community-**
By the end of grade twelve, students will:

D.12.1 Participate productively in workgroups or other collaborative learning environments
D.12.2 Use information, media, and technology in a responsible manner
D.12.3 Respect intellectual property rights
D.12.4 Recognize the importance of intellectual freedom and access to information in a democratic society

**Graduate School Competencies**

Similarly to identifying high school graduation requirements and standards, it is also appropriate to identify those IT competencies required of admissions for graduate schools to better determine UND graduation requirements. The following graduate schools are a sampling of
schools that require information technology literacy. These requirements apply to majors other than information technology or computer science which would have more stringent requirements as expected.

The University of Wisconsin-Madison (UW) School of Business requires “all incoming Master's students to own or have access to a personal computer and have a working knowledge of its operating system.” In addition, UW suggests that students become familiar with the following application software before classes begin. These include word processing, spreadsheets, statistics (Minitab), presentation software and graphics (http://www.bus.wisc.edu/graduateprograms/evemba/newad/computer.asp).

The School of Library and Information Science, University of South Carolina, (USC) (http://www.libsci.sc.edu/program/computer.htm) states

All students will need daily access to a computer and the Internet throughout the entire Masters of Library and Information Science, Certificate, and SLIS Degree Programs. Students must have a basic competency level in using standard office software in the following areas:

- Word Processing and Mail Merge
- Spreadsheet
- Graphs
- Presentation
- Database
- Attaching files to an email

In addition, USC informs graduate students that “throughout the program, work for courses will often require that you know how to use standard office software, such as spreadsheet, presentation, and database applications. However, the basics of software use are not taught within the curriculum of the program. “

The official University of Florida (http://www.circa.ufl.edu/computers/) computer requirements for all students both undergraduate and graduate are:

Access to and on-going use of a computer will be required for all students to complete their degree programs successfully. Effective with the Summer B 1998 term, the University of Florida expects each student entering the junior year, as well as each student new to the university, to acquire computer hardware and software appropriate to his or her degree program.

Competency in the basic use of a computer is a requirement for graduation. Class assignments may require use of a computer, academic advising and registration can be done by computer, and official university correspondence is often sent via e-mail.

While the university offers limited access to computers through its computer labs, most students will be expected to purchase or lease a computer that is capable of dial-up or network connection to the Internet, graphical access to the World Wide Web, and productivity functions such as word processing and spreadsheet calculation. Costs of meeting this requirement will be included in financial considerations.
Required technology competencies for students entering the Graduate School of Library and Information Studies at the **University of Rhode Island** include a basic knowledge of information technologies ([http://www.uri.edu/artsci/lsc/techcomp1.html](http://www.uri.edu/artsci/lsc/techcomp1.html)).

1. **Computer system software**: You should have a basic familiarity with relevant operating systems or a graphical user interface environment, (e.g., MS-DOS or Mac OS), including the ability to install programs, install peripherals and associated software, and operate programs. You should be familiar with basic terminology such as directory, folder, file, extension, etc.

2. **Word processing**: You should be able to create, edit, save, print and manipulate document files with at least one common commercial word processing program such as Microsoft Word or WordPerfect.

3. **Spreadsheets**: You should be able to set up, edit, save, sort, print and manipulate data and use basic functions such as sum, average, median and mode with at least one commercial spreadsheet such as Excel or Lotus. Basic skills using a spreadsheet program are prerequisite for taking LSC 502.

4. **Data Bases**: You should be able to set up, edit, save, sort, search for, print and manipulate data using at least one commercial data base program such as ACCESS or FileMaker Pro. Basic skills using a data base program are prerequisite for taking LSC 508.

5. **Data Communication and Networking**: You should either have your own established account with an Internet provider or have registered for a URI Network ID and Password to access the Internet by the first week of class. You should be able to send, receive, forward, attach, and print electronic mail messages. You should have a working knowledge of an Internet browser such as, setting up preferences, making bookmarks, using URLs and links, and performing basic searching. You should have a working knowledge of listservs including joining, participating, and quitting a listserv.

6. **Information Retrieval**: You should be able to use an online library catalog and to search and retrieve information on the Internet at a basic level. During the first semester, you will be required to develop competencies to search bibliographic databases commonly found in a library (e.g., Academic Index, FirstSearch, InfoTrac, etc.).

7. **Basic Troubleshooting**: You should be able to perform basic troubleshooting by using online help and appropriate instructions in standard manuals.

Remediation to acquire the above competencies is also listed on the website. Students are directed to face-to-face workshops and online tutorials both on campus and elsewhere.

   a. By taking the appropriate free short courses offered by IITS on URI campus. See Website: [http://www.uri.edu/ois/iits/education/education.html](http://www.uri.edu/ois/iits/education/education.html)

   b. By participating in relevant courses elsewhere (e.g., CCRI or another local technical college).

   c. By self study using University self-training program. The URL is: [http://www.uri.edu/ois/iits/education/education.html](http://www.uri.edu/ois/iits/education/education.html)

   d. For additional options, please visit GSLIS Web site:

      - net.Tutor at Ohio State University [http://gateway.lib.ohio-state.edu/tutor/](http://gateway.lib.ohio-state.edu/tutor/)
      - Internet Navigator Home Page [http://medstat.med.utah.edu/navigator](http://medstat.med.utah.edu/navigator)

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**Employer IT Literacy Expectations**

students were surveyed as to their expectations regarding five categories of computer literacy skills. The five categories were

- Creating documents and multimedia
- Working with computer programs
- Managing databases
- Manipulating numeric data
- Computer networks

The results of the research indicated that 83.3% of employers believe computer competency skills are either important or very important when making a hiring decision. Employers, 96%, expected basic word processing skills with 65% not believing desktop publishing skills relevant. However, 75% of employers desired basic graphics or presentation software skills. Internet document creation was considered not relevant by 70% of employers but these were willing to train.

Installing or upgrading software was not seen as an important skill but the ability to create macros for individual use was considered as desirable by 64% of respondents. As for work with databases, basic data entry and editing skills were viewed as needed by 83%. Spreadsheet skills including performing detailed analysis was highly regarded by 86% of employers. Possessing email skills rated next to highest of all expectations with 93% of respondents expecting experience with electronic communication. Online and Internet searching was also considered valuable by 63.3%.

Although this study was specific to computer skills, comments from employers indicated that communication skills, problem-solving skills, and adaptability to changing technology were also necessary to being computer literate.

The impact of technology on jobs in general has changed the qualifications needed by most workers. In an article by Carnevale and Desrochers (2001), information technology has caused workers to continually refresh their skills especially when software giants such as Microsoft upgrade their products every two years. They report that “employers want to hire workers with strong certified skill thresholds, and then complement that basic foundation with limited amounts of training specific to the industry, the company, or changes in work processes or technology. In other words, they want to hire the most training-ready employees” (p. 42).

Effective Practices

With the presence of information technology in some way part of every facet of daily life, institutions of higher education are incorporating the use of computers and computer technology into the teaching, learning, and business environment. Kasowitz-Scheer and Pasqualoni (June 2002, http://www.ericit.org/digests/EDO-IR-2002-01.shtml) identified a trend in information literacy to be “an increase in remote access to information and a demand for more rapid, anytime-anyplace sharing of information.” This suggests that information literacy and IT skills, knowledge, and attitudes are becoming interdependent. Many institutions referenced in this section of this report validate this integration and are part of the trend identified by Kasowitz-Scheer and Pasqualoni.

The University of Washington has established UWired, which “works to promote and support access to technology, fluency in information technology and resources, and innovation in teaching and learning through technology (http://www.washington.edu/uwired/). Workshops are
offered to students on a “drop-in basis or arranged with an instructor and tailored to the needs of a particular course… Two to three dozen 1-3 hour software skills workshops are offered each quarter, teaching students how to create professionally formatted papers, presentations, and web pages… Class-based workshops are similar to the drop-in workshops, except these are tailored to instructor requests.” In these workshops, help may be provided for assignments. An example would be to assist students in the design of a web page for the class or help them learn about online tools and/or services. Online assistance is also provided for software offered in computer labs.

Bowling Green State University recognizes that “fostering student knowledge of technology-based tools and applications is key to future professional success” (http://www.educause.edu/ep/ep_item_detail.asp?ITEM_ID=130) and thus has established the Student Technology Center that promotes student technology literacy. “StudentTech provides free technology-based services to students not found elsewhere on campus.” Through this program the following eight service programs are offered.

- Technology Skill Development in One Hour (or Less) Tutoring Sessions
- Large and Small Group Workshops
- Task-Based Online Tutorials
- Digital Video Program
- Laptop Loan Program
- Personal Technology Trainer Program
- Monthly Special Events
- Annual Tech Fair

George Mason University has instituted technology across the curriculum in an effort to graduate all liberal arts students with “an ability to use technology tools to solve problems and create products relevant to their area of study” (http://www.educause.edu/ep/ep_item_detail.asp?ITEM_ID=84). In an article by Agee and Holisky (2000, www.educause.edu/ir/library/pdf/EQM0041.pdf) the George Mason program is described. The institution took the approach that the emphasis was not to be on “technology skills themselves, but on the use of technology as a tool for learning. The technology goals had to be subsumed by the content” (Ibid, p. 7). Surveys indicated that the faculty expected that technology skills would be acquired by students outside the classroom; hence, technology support was critical. The Student Technology Assistance and Resources (STAR) Center was established to “respond to the difficulties of providing students with useful and effective resources to learn technology skills outside of the regular classroom” (http://www.educause.edu/ep/ep_item_detail.asp?ITEM_ID=74). Working with the corporate and internal communities “consensus was reached on the basic and advanced technology skills needed in today’s world by students in order to be successful in their course-based learning, their major fields of study, and in their first jobs after graduation” (Agee and Holisky, 2000, www.educause.edu/ir/library/pdf/EQM0041.pdf). The identified goals were:

- Electronic collaboration
- Electronic document creation
- Use of electronic tools for research and evaluation
- Use of spreadsheets to manage information
- Use of databases to manage information
- Use of electronic tools to analyze quantitative and qualitative data
- Use of geographic information systems for handling spatial data
- Familiarity with legal, ethical, and security issues
- Working knowledge of IT platforms
Progress made by students in acquisition of these skills, knowledge, and attitudes was tracked with the results charted in a grid format. A computer-based test, Tek.Xam, was used to measure “information literacy, problem-solving, and technology skills” (Ibid, p. 10).

At Washington and Lee University, information fluency skills for students were deemed important and efforts to incorporate the skills into the curriculum were identified as a preferred method. Faculty, librarians, and technologists defined these to include

- Thinking critically about the information needed
- Understanding the structure and types of information in a discipline
- Finding information to meet specific needs using search engines, bibliographical databases, and other tools as needed
- Evaluating the quality of information found
- Analyzing the information using electronic spreadsheets and statistical analysis tools
- Presenting the information selecting from among electronic and other media as appropriate

They determined it desirable to teach skills in a context where the skills can be applied directly. “Our experience in teaching workshops confirmed that students learn best when skills are taught in context. For instance, students quickly forget their skills in developing Web sites or performing research with Web databases if they can’t apply those skills in a course that requires their use” (Overholtzer, J. & Tombarge, J., 2003, p. 55 www.educause.edu/ir/library/pdf/ EQM0319.pdf). Hence, a pilot program was developed involving an information-intensive course that required a variety of software and data analysis skills. Overall goals were achieved by incorporating the following information fluency skills and concepts into the methodology of the course.

- Applying critical thinking skills to research
- Learning about issues regarding copyright, ethics, and source citations
- Selecting and evaluating resources
- Learning database structure and searching skills
- Using Internet sources
- Locating and retrieving statistical data
- Mastering Excel – basic skills, statistical tools, creating graphs and charts, importing data
- Presenting information in an appropriate media, e.g. PowerPoint or via the Web

At the heart of the pilot were peer mentors, students who had completed the course previously and were proficient in software and research skills. Web and online tutorials were provided to assist students in learning spreadsheet and presentation software. Assessment of the projects developed by the students in the course demonstrated the success of the program. “The results in the final projects, the keystone of the course, were clearly superior – there were no poor papers” (Ibid, p. 57).

Mary Washington College determined that a “technological competency” is needed by all students and that a “major subset of technological proficiency is competency with computers” (Ayersman, D., Ackermann, E., & Zisman, P., 1996, http://www.saintmarys.edu/~psmith/ayers96.html). The college initiated a two-phase integration approach to realize this objective: provide students basic technology skills training and then use those skills in the learning environment. Skills were identified as

- Create a word-processed document
- Create a spreadsheet that involves calculations
- Access online information from the Web
• Use the campus computer network to send and receive information
• Electronically locate topicaly relevant information within the campus library
For students to achieve these competencies, the College identified the following goals and objectives that need to be in place.
• Students should progress from simple to complex uses of technology
• Students should progress from being consumers to producers of technology-based information
• A logical and progressive plan should exist that results in graduating students having fundamental technological skills
• All students must have access to technology - access must not be inhibitive to the goals of technological competency
• Existing coursework that integrates technology must be recognized
• Future coursework (proposed courses) should be targeted as potentially inclusive of technology
• The Restructuring Task Force on Instructional Technology should act as the screening committee to evaluate syllabi of potential Technology Intensive courses
• Explicit criteria must be developed that will identify Technology Intensive courses
• Extracurricular training must be provided to accommodate students needing additional technology-based skills
• Technology-based projects that students develop should be included in their portfolios

In the Fall of 1995, **East Tennessee State University** instituted a new general education program that required students to take courses in three proficiency areas: oral communication, writing, and using information technology. In reviewing the list of 507 courses offered for Spring 2003 in all three proficiency areas, there are multiple courses listed for using information technology in each discipline ([http://www.etsu.edu/reg/intensive/](http://www.etsu.edu/reg/intensive/)). One course is required to meet the competency. Information technology use is also listed as one of the five proficiencies in the general education core.

In addition, the general education program at ETSU seeks to ensure that graduates possess at a minimum the following proficiencies:
1. The ability to write clear, coherent, and grammatically correct expository prose;
2. The ability to communicate orally in a succinct, persuasive, and grammatically correct manner, as well as to adapt one’s mode of communication to the needs and expectations of various audiences, including those who are literate in various academic disciplines;
3. The ability to read and comprehend serious texts in a variety of academic areas, to relate what one reads to what one knows, and to distinguish fact from opinion;
4. The ability to understand and make use of basic mathematical concepts and tools that are of general use in various academic disciplines; and
5. The ability to use information and creative resources that are available electronically.

**Peer Institutions**

Five peer institutions, listed below, identified by the University of North Dakota were contacted requesting information concerning student IT literacy requirements at their respective institutions.
• Ohio University – Main Campus
Each university was first sent an email by Dr. Jim Shaeffer requesting from each Chief Information Officer (CIO) his/her cooperation in providing information to the Collegis Senior Consultant compiling this report. A follow-up email was then sent to each CIO requesting any information that could be provided in regard to the following five items.

1. What are the student IT literacy skills, knowledge, and attitudes that your institution requires upon entrance to the University?
2. How does your institution test for these IT literacy skills, knowledge, and attitudes?
3. How do you remediate when these skills, knowledge, and attitudes are deficient?
4. What IT literacy skills, knowledge, and attitudes does your institution require upon graduation?
5. How does your institution test for graduation IT literacy requirements?

A follow-up email from the Collegis Senior Consultant was sent to those institutions who had not responded two weeks after the initial correspondence.

Information was received from State University of New York – Buffalo and Southern Illinois University – Carbondale. See Appendix B for responses.

**State University of New York (SUNY) – Buffalo**

SUNY Buffalo informs students that technology has been “infused” into the curriculum and a computer will be needed in their “living space.” The University also tests for IT proficiency as part of the CIRP Freshman Survey ([www.gseis.ucla.edu/leri/c_button1.html](http://www.gseis.ucla.edu/leri/c_button1.html)). Students are also asked how they prefer to learn about computers, i.e., classroom instruction, exploring on their own, self teaching via tutorials and guides, and/or learning from family and friends. Local data from the CIRP survey of incoming freshmen, completed in July 2002, prior to beginning their academic studies at SUNY - Buffalo, is included in Appendix C.

An extensive list of student IT literacy expectations is posted on the SUNY Buffalo web site ([http://www.buffalo.edu/iconnect/gettingstarted/expectations.html](http://www.buffalo.edu/iconnect/gettingstarted/expectations.html)). This list was developed by the Student IT Literacy Group and is based on competencies described in *Being Fluent with Technology* from the National Academy of Sciences.

Remediation options are also listed online and are described in the following terms (Peters, S., email correspondence. April 23, 2003).

“special programs that provide intensive IT training for our incoming EOP students and Academic Challenge Program students. These students have the opportunity to be ‘in residence’ at the University for three weeks in July, and attend hands-on IT sessions that introduce them to the word processing, Internet, library, information literacy, and other computing skills they will need in their classes.

UB also offers free IT workshops for students. During Opening Weekend (the weekend before classes begin each Fall), we offer IT workshops and extensive help to students who are setting up their computers. During the academic year, we provide workshops as well ([http://www.itworkshops.buffalo.edu](http://www.itworkshops.buffalo.edu)).
We also provide incoming students with a ‘Tech Tools CD’ that provides them with the Internet software they need (browsers, plug-ins, players, email clients), antivirus software, and programs/scripts that configure their computer Internet access/connections.

Finally, we tell incoming students about the for-credit IT literacy courses that are offered each semester. Many academic programs make completion of an IT literacy course mandatory for graduation.

Graduating students must pass a ‘Library Skills/Information Literacy Workbook.’ There is also an IT/computing literacy course requirement for many academic programs.”

An annual student skill survey of undergraduate, graduate, and professional school students is conducted to track proficiency progress. Prior to the implementation of the [current] survey students were asked to rate their skills. Over the past several years in all skills areas and applications students self-reported intermediate to advanced skill levels. This finding is consistent with SUNY – Buffalo peer institutions and thus prompted the annual skill survey.

To determine IT literacy proficiencies upon graduation, students at SUNY – Buffalo must complete and pass a ‘Library Skills/Information Literacy Workbook.’ This workbook is based on ALA Guidelines for Information Literacy. Many academic programs make completion of an IT/computing literacy course mandatory for graduation” (Ibid).

In addition, the state of New York has recently required that students demonstrate specific IT skills in the "information/knowledge management" area and currently the University is determining how best to test for these at this time.

The School of Engineering will be piloting e-portfolios Fall 2003 as yet another validation of IT skills and capabilities of students.

**Southern Illinois University**

Southern Illinois University assumes the use of computers in classes but does not test for any computer or information technology skills. For those students who find they need to acquire or enhance technology expertise, SIU provides online skills enhancement in student labs. There are no IT literacy requirements for graduation nor is there any testing to determine skill level or proficiency.

**Findings and Recommendations**

During a series of interviews and focus groups at the University of North Dakota campus, faculty and staff representing the Student IT Literacy Committee, Outreach, the Library, the Medical and Law Schools, CILT, and Help Desk were asked to identify IT literacy skills, knowledge, and attitudes of students upon entrance to and graduation from the University, how to test for these, and what remediation should be provided. A group of undergraduate students were also
interviewed. Similarly, department heads were surveyed as to entry-level IT skills for new students taking courses from their departments, which IT exit competencies were expected from graduates, and how were departments providing opportunities for students to gain proficiency.

The findings in each of the five benchmark categories are listed below in shaded text boxes and these are numbered sequentially. Recommendations follow and are numbered to correspond with the findings.

**IT literacy skills, knowledge, and attitudes for incoming UND students**

1. Word processing, Web/Internet skills including search strategies and information validity, email and electronic etiquette, ethical use of computers, copyright, privacy, and security were identified as necessary components of IT literacy at UND.

Responses from interviewees, including students, were very similar. The most common response when asked to identify which IT skills, knowledge, and attitudes new students should possess was basic word processing. This includes keyboarding, creating, editing, saving, and printing simple formats to complete assignments. Editing was described as cutting, pasting, spell checking, setting tabs, changing fonts, underlining, bolding, and inserting page numbers and tables.

The need for word processing skills was verified by the Help Desk. Most of the calls received two weeks prior to the start of the semester through the first six weeks of the semester come from students asking for word processing assistance. These include help for formatting (margins, tabs, justification, etc.), headers and footers, and table set-up. Discipline-specific software questions are referred to the department. Other types of Help Desk requests from students are:

- Accessing a student email account
- Dial-up set-up from home although most calls are from students on campus
- Change of password
- Set-up of different email programs
- Password resets for Blackboard
- Virus questions and clean-up
- Operating systems questions
- Explanation of error messages

Web/Internet skills of finding a specified URL, downloading the information, and printing or saving the information so that it can be retrieved at a later time were also considered important skills by both survey respondents and interviewees. Employing successful Web search strategies was included in Web/Internet skills. Being able to determine if the information located was from a reliable source was also mentioned. It is interesting to note that the Help Desk did not report an abundance of Web/Internet questions from students.

Sending, reading, and creating email was also considered an important skill by interviewees and survey respondents. Attaching documents especially assignments was considered essential as well as being aware of electronic etiquette. Being able to distinguish between distribution lists and listservs and sending information from the Internet to email was also identified.
Awareness and knowledge of the ethical use of computers, copyright, privacy, and security were also considered important by the majority of those who responded to the survey and by approximately one third of the interviewees.

There were also a number of skills, knowledge, and attitudes that were identified by various interviewed individuals and by some respondents of the survey. These include

- Presentation skills (PowerPoint)
- Common computer terminology, e.g. clear the cache, cookies, logon, etc.
- Spreadsheets (Excel)
- Databases in association with library resources
- Basic operating system operations
- Taking an online survey
- Basic Blackboard skills
- Naming conventions for passwords
- Drawing skills
- Use Web-based applications to request appointments, pharmacy, etc.

Recommendations:
1.1 UND should define IT literacy in terms of the broader definition that integrating computer skills and information literacy standards.
1.2 UND should consider the following list of skills, knowledge, and attitudes in determining IT literacy standards.

Skills:
- Word processing
- Operating system tools
- Email
- Access to and location of information on the Web/Internet and Library databases
- Search strategies
- Spreadsheets
- Presentation software
- Basic troubleshooting

Knowledge:
- Validity of data obtained electronically
- Copyright and intellectual property
- Security
- Implications of electronic communication and transmission of information

Attitudes:
- Ethical use of information
- Privacy
- Electronic communication etiquette

1.3 UND should determine proficiency levels for the above proposed standards.
1.4 UND should formally adopt IT literacy as an additional Cross-Disciplinary Ability or incorporate it into existing Abilities.
1.5 UND should establish an ethical use policy and inform all students so that they may abide by its precepts.
1.6 UND should consider requiring students to sign a document promising compliance with the UND ethical use policy.
1.7 In addition to the requirements identified in 1.2, UND should consider the addition of presentation software and basic database concepts and skills to its literacy requirements.

1.8 UND should inform incoming freshmen or students new to the University that IT literacy requirements exist and that it would behoove students to gain proficiency in each of the IT literacy areas before beginning classes. This notification could be incorporated into the University marketing and recruitment strategies prior to admission.

1.9 UND should consider adopting and adapting the EDUCAUSE Consumer Guide to inform students of the technology advantage that the university has to offer students.

Testing of IT skills, knowledge, and attitudes upon entrance

2. Testing for IT literacy does not formally exist at UND, however, interviewees suggested that literacy assessment could be accomplished through student self-reporting on the admissions form, professors querying students as needed, and/or an IT literacy proficiency exam administered during orientation.

Interviewees believed that IT literacy skills, knowledge, and attitudes could be tested in a number of ways ranging from student self-reporting to a proficiency exam similar to those administered for English.

Self-reporting was suggested as one form of determining the proficiency level of students in the area of information technology. Items could be included on the UND admissions form or on a questionnaire administered during orientation. Currently, students are asked to self-report their skill level when signing up for email. Another suggestion was simply for professors to query students as the need arises in the classroom.

The development of an IT proficiency exam administered during orientation was also suggested. This could take the form of a written exam or one that is Web-based. Creating, editing, and printing MS Word documents and Excel spreadsheets were suggested. Accessing the Internet and conducting a search should also be included. There was also discussion concerning testing for ethical use. One suggestion was to have each student sign a “pledge” not to violate copyright and to respect intellectual property.

Recommendations:

2.1 UND should consider some form of testing for IT literacy proficiency for students upon entrance to the University allowing for tracking trends over time and adjustments needed to subsequent remediation measures. A possible assessment instrument is the CIRP Freshman Survey www.gseis.ucla.edu/feri/c_button1.html, with the addition of IT literacy items provided by the university. Sandy Peters, Associate Director, Academic Services, CIT, at the University of Buffalo is a resource as to the success of this instrument at SUNY Buffalo.

2.2 UND should explore the use of Web/online resources as the testing medium for identified IT literacy competencies.

2.3 Alternative testing procedures should be considered for those students who are at a distance or are challenged in any way preventing them from onsite, in-person testing method(s) that UND should implement.

2.4 UND should explore the feasibility of administering an annual IT literacy survey and track yearly results to monitor proficiency levels.
Remediation when IT skills, knowledge, and attitudes are deficient

3. Some UND departments provide options for students to become IT literate within specific disciplines with many faculty members incorporating technology instruction and assistance into the classroom learning experience.

4. Instruction and assistance in technology basics for students is currently available through elective workshops and a one-credit Introduction to Computers course, tutoring, computer labs, library, and the UND Help Desk.

5. Many students have the tendency to either seek help from their peers or experiment on their own because they perceive that is easier than taking a workshop or class.

6. Some divisions within UND have established a Laptop program requiring students to own and use a personal computer for coursework and study.

Survey respondents listed discipline-specific required courses that teach IT skills, knowledge, and attitudes within the context of the subject matter. Courses were listed that are both within and external to the department. Three departments offered internships or co-ops. Suggestions for additional ways remediation could take place were faculty modeling skills and then providing assignments that allow for students to practice; having technology support available to assist faculty in the integration of IT into the curriculum; and games, demonstrations, and independent research. See Appendix A for complete survey results. Currently, many faculty members provide instructions for the technology needed in classes through handouts, one-on-one meetings, or demonstrations.

Interviewees suggested that there be a required general education course or a variety of courses available in which students could attain minimum skill level. A one-credit Introduction to Computers lab is currently available for students; however, this course is not required. Workshops addressing the most common areas of need and individual tutoring were also considered possible ways to attain required competencies. Currently technology workshops are offered for students at a cost of $150 that are not associated with a specific discipline. Online tutorials and self-help Web sites in the public domain were considered options also. The Help Desk maintains a Web site posting of user and technical information as well as Frequently Asked Questions with explanations.

Establishing a technology-across-the-curriculum initiative was suggested as the most effective method of ensuring that IT literacy for all undergraduate students be achieved. Incorporating technology skills, knowledge, and attitudes into curricula could provide students with the discipline-specific skills needed. The Library could be central to this initiative.

Workshops are offered by the CILT and ITSS that are open to students and address basic technology skills. For example, MS Office Suite training offered during the day is currently available for students. The library also offers instruction to classes at faculty request as well as instruction for individual students in search strategies and the location of information. Interviewees considered library assistance helpful and integral to student success.

The Law School conducts one- to two-hour sessions during orientation week teaching IT skills and principles. They have found that approximately 70% of their incoming graduate students are comfortable with computers, 15% are below the comfort level, and 15% are “amazing” with
computers. In these sessions, ethical use of information and associated issues such as the downloading of music are addressed.

The Aerospace division offers a one-semester required course that assumes students have no technology expertise and teaches the technology that students will need to be successful in the program. This course is offered in conjunction with a laptop initiative in which students have purchased machines.

The UND Help Desk advertises its telephone number for students to request assistance in freshman orientation packets and in the Help Desk newsletter that is published every six months. In addition the phone number is posted in computer labs.

Students also receive assistance in computer labs from lab technicians, however, this was considered inadequate due to the limited amount of time lab techs have to spend with individual students and the breadth and depth of lab tech expertise.

Students who were interviewed reported that currently the two ways that most students gain technology skills, knowledge, and attitudes are firstly, seeking information and instruction from their peers and secondly, experimenting on their own until they can “figure it out.” Students also said that it was easier to ask friends for help than to seek it elsewhere. Students also commented that they believed that more students would call the Help Desk if the Help Desk phone number was advertised more.

Recommendations:
3.1 If IT literacy standards are adopted, UND should review current intervention strategies to determine appropriateness in assisting students to meet IT literacy requirements.
3.2 UND should explore the benefits of launching a technology-across-the-university initiative to allow core and discipline-specific technology competencies to be attained by students throughout their UND educational experience. UND should consider the development of a required IT literacy course that combines IT and information literacy competencies for all incoming students.
3.3 UND should explore the possibility of offering online/Web-based tutorials to accommodate students on a 24/7 basis. The following commercial online tutorials may match the needs of UND students.
   - Microsoft: http://www.microsoft.com/education/tutorial/classroom/
   - NetG: http://www.netg.com/

4.1 UND should review the Law School one- to two-hour sessions during orientation week that teach IT skills and principles and ethical use of information for possible replication across the university.
4.2 SUNY Buffalo makes available information concerning ethical behavior through Web links http://www.buffalo.edu/iconnect/gettingstarted/expectations.shtml as does the University of California, Irvine http://www.ics.uci.edu/computing/ethics/ethics_summary.php. UND
4.3 UND should continue to offer free technology workshops through CILT and ITSS to provide alternatives in acquiring needed skills.
4.4 The UND Library should continue to explore ways to expand IT literacy instruction and assistance to classes and individuals.
4.5 Tutoring for IT literacy skills should be continued by UND to help those who learn best in face-to-face, one-on-one situations.
4.6 The UND Help Desk should institute Service Level Agreements for students to best serve students who request assistance.

4.7 The UND Help Desk should identify additional ways to publicize the Help Desk number throughout the university.

5.1 Identification of public domain or free access websites for self-help should be identified by UND and this information widely communicated to students.

5.2 Partnering with institutions that have extensive online IT training e.g. the Indiana University – Bloomington - [http://ittraining.iu.edu/iub/](http://ittraining.iu.edu/iub/) or developing in-house programs are also possible alternatives.

5.3 UND should consider producing either through online download or individual CDs, a set of standard software applications that could be distributed to each student upon entrance to the university. A procedure of distributing upgrades for students during their time of attendance at UND should be established.

6.1 UND should explore the benefits of an institution-wide Laptop initiative. A possible model is the Aerospace division laptop program.

6.2 UND should compare the Aerospace laptop program with laptop initiatives at other institutions to identify effective or best practices.

**IT exit skills, knowledge, and attitudes for graduating students**

7. UND has not identified IT literacy skills, knowledge, or attitudes for students graduating from the university.

Currently, there is no formalized set of IT literacy skills, knowledge, or attitudes for students graduating from the University of North Dakota. Many discipline-specific courses in which IT competencies are achieved by students, do not specifically address these as separate outcomes but are considered more of a necessary tool in learning content.

Interviewees suggested that the same IT literacy skills that would be required at entrance to the university should be required upon exit but with more in-depth knowledge and proficiency. Word processing, spreadsheets, and discipline-specific software were the three most often mentioned as necessary upon graduation.

Being able to access information on the Web/Internet and having the ability to judge the value of that information again were considered valuable. In addition using search strategies for easy and efficient access to information was listed as what students should be able to do upon graduation from UND.

Interviewees as well as survey respondents included presentation software skills and knowledge as desirable for UND graduates. Faculty and staff interviewed commented that being able to navigate an existing slide show plus speaking to the content on each slide, demonstrated proficiency. Students, however, felt that they needed to be able to design, create, and edit a slide show as well as navigate. Adequate public speaking skills so as to present themselves in a professional manner were also deemed important by students.

Other exit skills listed by survey respondents were

- Use of statistical packages
- Basic programming skills
• Data file management
• Web page development and content
• Computer drafting
• Database
• Networking

Recommendations:
7.1 All undergraduate academic divisions at UND should identify exit IT literacy competencies specific to each discipline.
7.2 UND should identify a common set of IT literacy skills, knowledge, and attitudes based on the discipline-specific literacy competencies identified academic departments.
7.3 Academic divisions should review effective or best practices at other institutions to determine appropriate skills and skills levels.
7.4 Academic divisions should review current interventions for adequacy in providing opportunities for students to gain exit IT literacy competencies.
7.5 The Library and CILT should work with academic divisions to determine how they may support and assist students in meeting IT literacy exit competencies requirements.

Testing for IT exit skills, knowledge, and attitudes at graduation

8. No specific, formal testing for IT exit skills, knowledge, or attitudes is currently conducted at UND.

No formal testing for exit IT literacy skills, knowledge, or attitudes for those graduating from UND was identified by interviewees or survey respondents. In many cases, students who are successful in courses are of necessity, IT literate. They use technology to complete assignments and collaborate with peers and faculty through the use of electronic communication. Hence, many interviewees believed that an indication that students are IT literate upon graduation is simply the fact that they are graduating. If students can complete their course work successfully, then they have demonstrated that they have the IT skills, knowledge, and attitudes needed to be successful in graduate schools and/or the workplace. This would especially be true if technology-across-the-curriculum were instituted. Faculty would determine and verify the skill level of students as part of the process of students earning freshman through senior status.

Others described proof of IT literacy as being able to produce professional looking documents especially a resume. This plus other electronically produced or stored documents and projects could be part of student e-portfolios. Projecting a professional image was often mentioned as a measure of success whether the form is written as in a resume or document or in speaking when giving a presentation.

Another indication of IT literacy could be the ability of students to submit well-researched, properly annotated, and content-valid assignments electronically and communicating appropriately with the faculty via email and Blackboard.

Recommendations:
8.1 Academic divisions should consider requiring e-portfolios as a means of students demonstrating IT literacy proficiency.
8.2 Academic divisions should consider requiring a percentage of assignments to be submitted electronically, to demonstrate IT literacy proficiency.
8.3 UND should explore the desirability and feasibility of instituting an institution-wide exit exam to test for core IT literacy proficiency.

Benchmarking Implications

The University of North Dakota joins with nearly two-fifths (43.6%) of all colleges and universities nation-wide in addressing the issues of student IT literacy. This percentage has steadily climbed in the last ten years. In the early 1990s, approximately 30% of institutions had “computer” literacy requirements with an emphasis on what students needed to know and be able to do upon graduation. Recognizing the importance of being computer literate so as to have the advantage in obtaining jobs in the workforce or doing well in graduate programs, higher education institutions focused on after-graduation computer skills.

Today, there has been a shift from after-graduation computer literacy to the skills, knowledge, and attitudes of a broader-defined, information technology. In addition to the extended scope, colleges and universities are concerned with IT literacy for students at the beginning of their higher educational experience (Green, K., February, 2003, http://www.convergemag.com/magazine/story.phtml?id=43511). An increasing number of institutions are offering online admissions and communicating electronically between counselors and advisors and potential and incoming students. Likewise, students are making decisions about colleges and universities as a result of Web searches and email correspondence. Faculty members are using course management systems, such as Blackboard, as a means of providing opportunities for interaction and collaboration as well as distributing class materials and assignments. Technology as part of the overall learning and university experience is becoming more commonplace and students need to be able to not only survive but thrive in such an environment.

Thus, this benchmarking study has sought to provide information on guidelines and recommendations from organizations that have conducted research concerning the skills, knowledge, and attitudes that define the IT literate person. Several states have identified competencies that are expected of high school graduates in terms of technology. These serve to inform the University of North Dakota of the potentially technology-savvy, traditional-age freshmen coming to campus. Graduate school entrance requirements provide information on technology expectations acquired during undergraduate studies. Likewise, employers who hire recent college graduates assume that they come to the workplace with certain technology capabilities.

To meet these expectations, colleges and universities throughout the country have instituted IT literacy programs. The programs vary in comprehensiveness and intensity; however, they all point to the fact that IT literacy is important. The mere fact that UND is researching this subject in accordance with two of the institution-wide action strategies attests to the concerns of the university as it pertains to student success.
Appendix A: UND Student IT Entry/Exit Skills Survey Results

1. Identify the necessary entry-level IT skills for new students taking courses from your department. This includes not only those majoring or minoring in your academic area, but all students who might take entry-level courses from your department.

- 23 - basic word processing skills (create and save files, cut and paste, check spellings, …)
- 22 - basic web browser skills (find course web pages, download instructor-provided files)
- 23 - basic e-mail skills (contact instructor, turn in homework as an attachment, …)
- 19 - basic knowledge about ethical use of computers, copyright law and privacy issues

**New suggestions**

- Presentation Skills (PowerPoint)
- Advanced knowledge about word processing, spreadsheets, data bases (including design), graphing, drawing, e-mail, use of the WWW
- Basic search / locate skills
- Ability to use web based applications to request appointments / pharmacy etc.
- Students working as peer educators use PowerPoint for education and outreach
- Basic data entry
- Blackboard program usage skills
- Basic knowledge of computers and terminology
- Proficiency demonstrated in Keyboarding

2. Identify the IT exit competencies you expect your graduates to have upon completion of your degree program.

- 23 - basic word processing skills
- 22 - basic web browser skills
- 23 - basic e-mail skills
- 20 - basic knowledge about ethical use of computers, copyright law and privacy issues

**New suggestions**

- Presentation skills, grade book, computer programs related to specific disciplines such as science or math
- Presentation skills (PowerPoint)
- 3 - Statistics (SPSS) statistical analysis skills
- Spreadsheet data manipulation and graphing
- Basic computer programming skills
- Computer data file management
- Everything identified in #1
- Develop web pages
- Develop internet content (text, graphics, streaming, etc)
- Analyze quality / info on internet
- Decision making skill to determine what is real and what is fraudulent regarding health
- Students working as peer educators use PowerPoint for education and outreach
- Basic data entry
- Ability to utilize computer applications form computer-aided design/drafting to desktop
- Publishing, multi-media, electronic design, mfg, automation, programmable logic controllers
Advanced spreadsheet skills
Database skills – basic BusEd and CTE
Networking skills, Advanced Internet skills

3. If your lists of entry skills and exit competencies are not the same, explain how you intend your students to acquire the additional competencies expected of graduates?

**Required courses we teach in our department (specify)**
- Technology for Teachers
- Geog 377 and lab, Geog 471 and lab, Geog 474, Geog 374, Geog 574
- Marketing Research I and II
- AtSc 240, AtSc 370
- EdL 502
- Graphics, electronic editing
- IT 1222, IT 363, IT 343, IT 203, IT 412, IT 441, IT 452, IT 302, IT 212, IT 442, IT 311
- PEXS 501
- COUN 516: Research Lab

**Required courses from other departments (specify)**
- Acct 315, Isys 217
- Csci 160
- EFR 515 & 516
- PSY 541 & 542: Univariate and Multivariate Statistics

**Internships or co-ops - 3**

**New suggestions**
- Modeling specific technology skills in each of our courses and giving assignments that require their use
- Including examples of technology use in K-12 classrooms in our methods classes
- Having available a technology person to help teach how to integrate it into the curriculum
- Writing independent study
- Course requirements
- Via games (health related) aid demonstrations
- Students should be advised that employers we speak with would like to see students graduating with background knowledge/competencies in basic word processing, spreadsheets, and databases. We do not have the ability to teach all these competencies!! And should consider these skills as we make out IT plan.
- Independent research, thesis, dissertation
Appendix B: Comparison Table of Peer Institutions by Benchmarking Item

1. What are the student IT literacy skills, knowledge, and attitudes that your institution requires upon entrance to the University?

<table>
<thead>
<tr>
<th>Southern Illinois University-Carbondale</th>
<th>State University of New York-Buffalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is nothing formal; we do assume use of computers in classes.</td>
<td>No general admission requirements</td>
</tr>
<tr>
<td>Prospective students are</td>
<td></td>
</tr>
<tr>
<td>• Informed that technology has been infused into the curriculum, as well as into student services, and student life</td>
<td></td>
</tr>
<tr>
<td>• Advised that they will need a computer in their living space</td>
<td></td>
</tr>
<tr>
<td>Students for whom this would be a severe financial hardship (as determined by the Office of Financial Aid) are eligible to receive a computer on loan for the length of their undergraduate studies</td>
<td></td>
</tr>
</tbody>
</table>

2. How does your institution test for these IT literacy skills, knowledge, and attitudes?

<table>
<thead>
<tr>
<th>Southern Illinois University-Carbondale</th>
<th>State University of New York-Buffalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>We do not test</td>
<td>CIRP Freshman Survey – <a href="http://www.gseis.ucla.edu/heri/c_button1.html">www.gseis.ucla.edu/heri/c_button1.html</a></td>
</tr>
<tr>
<td></td>
<td>adding local computing/IT questions which students complete during July Orientation sessions prior to starting classes in the Fall semester</td>
</tr>
<tr>
<td></td>
<td>Survey students as to how they prefer to learn about computers –</td>
</tr>
<tr>
<td></td>
<td>• classroom instruction,</td>
</tr>
<tr>
<td></td>
<td>• exploring on their own,</td>
</tr>
<tr>
<td></td>
<td>• self teaching via tutorials and guides,</td>
</tr>
<tr>
<td></td>
<td>• learning from family and friends</td>
</tr>
<tr>
<td></td>
<td>Conduct annual Student IT Survey of undergraduate and graduate (and professional school) students. No longer ask students to rate their computing skills because they consistently rated their skills as intermediate to advanced for past several years in all applications and skill areas except database applications. This is consistent with data from our peer institutions.</td>
</tr>
<tr>
<td></td>
<td>Students enrolled in online distance learning courses are also provided with computer system and IT skill requirements. UB has a Blackboard/UBLearns computer assessment &quot;course&quot; for these students which enables these students to determine if they are prepared to take an online course</td>
</tr>
</tbody>
</table>

3. How do you remediate when these skills, knowledge, and attitudes are deficient?

<table>
<thead>
<tr>
<th>Southern Illinois University-Carbondale</th>
<th>State University of New York-Buffalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>We have online skills</td>
<td>Incoming freshmen and transfer students attend mandatory IT</td>
</tr>
</tbody>
</table>
| Enhancement in our student labs | Sessions (2 40-minute sessions) that are conducted in hands-on computing labs during Summer Orientation, prior to the start of Fall semester classes. During these sessions students learn to:  
- use their UB IT accounts,  
- set up/use their UB email,  
- use the student portal system (Mug),  
- use the UB Learns (Blackboard) course management system  
- use web registration and other student service applications,  
- introduced to extensive Library resources and services  
- informed of responsible use, staying safe online, and computer security.  
These sessions are developed by the Student IT Literacy committee with members from the Computing Center, the University Libraries, Academic Advisement, and Computer Science and Engineering faculty who teach IT literacy courses. |
|---|---|
| The Student IT Literacy group has also developed online materials for students, including:  
- a web site that tells students what faculty will expect them to know in terms of IT skills/capabilities, and  
- how they can acquire these skills.  
We update this web site each spring [http://www.buffalo.edu/iconnect/gettingstarted/expectations.html](http://www.buffalo.edu/iconnect/gettingstarted/expectations.html)  
We use the National Academy of Sciences report: “Being Fluent with Information Technology” as our guide for needed information technology skills. | Freshman Orientation occurs in July. In the weeks after Orientation, we send email messages to freshmen with tasks for them to complete, in order to reinforce and extend the IT skills that students were introduced to in Orientation sessions. |
| UB also offers special programs that provide intensive IT training for our incoming EOP students and Academic Challenge Program students. These students have the opportunity to be "in residence" at the University for 3 weeks in July, and attend hands-on IT sessions that introduce them to the word processing, Internet, library, information literacy, and other computing skills they will need in their classes. | UB also offers free IT workshops for students. During Opening Weekend (the weekend before classes begin each Fall), we offer IT workshops and extensive help to students who are setting up their computers. During the academic year, we provide workshops as well: [http://www.itworkshops.buffalo.edu](http://www.itworkshops.buffalo.edu) |
| We also provide incoming students with a “Tech Tools CD” that provides them with the Internet software they need (browsers, plug-ins, players, email clients), antivirus software, and programs/scripts that configure their computer Internet access/connections. | We tell incoming students about the for-credit IT literacy courses that are offered each semester. Many academic programs make completion of an IT literacy course mandatory for graduation. |
4. What IT literacy skills, knowledge, and attitudes does your institution require upon graduation?

<table>
<thead>
<tr>
<th>Southern Illinois University-Carbondale</th>
<th>State University of New York-Buffalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Students must complete and pass a &quot;Library Skills/Information Literacy Workbook&quot; in order to graduate. This workbook is based on ALA Guidelines for Information Literacy. Many academic programs make completion of an IT/ computing literacy course mandatory for graduation</td>
</tr>
</tbody>
</table>

5. How does your institution test for graduation IT literacy requirements?

<table>
<thead>
<tr>
<th>Southern Illinois University-Carbondale</th>
<th>State University of New York-Buffalo</th>
</tr>
</thead>
<tbody>
<tr>
<td>See 4</td>
<td>The State University of New York (SUNY) Board of Trustees has recently added an &quot;information/knowledge management&quot; requirement to the general education areas that all SUNY institutions must include in their programs. We are addressing this issue at this time. We will need to demonstrate that our students acquire specific IT skills in the &quot;information/knowledge management&quot; area</td>
</tr>
<tr>
<td>None</td>
<td>In addition, specific programs, e.g., engineering, have accreditation boards that also have specific IT literacy/fluency requirements. The School of Engineering will be piloting student e-portfolios this Fall 2003 as a way to demonstrate engineering student IT competencies/capabilities</td>
</tr>
</tbody>
</table>
Appendix C: SUNY – Buffalo CIRP IT Survey Results

The following survey results are from the CIRP survey administered to incoming freshmen in July 2002, prior to the beginning of their academic studies at SUNY – Buffalo.

Have a computer with Internet connection at home: ............................................................94%
Have completed a computer course in high school: ............................................................85%

Have at least basic email skills: ........................................................................................ 98.8%
   (ability to send, read, reply to email)
Have at least basic Internet skills: ........................................................................................ 99.4%
   (ability to launch a Web browser, follow Internet links, enter the URL of a specific internet site, create and use bookmarks)
Have at least basic word processing skills: ........................................................................ 99.7%
   (ability to enter, edit, copy, and move text)
Have at least basic spreadsheet application skills: ........................................................... 87.8%
   (ability to enter data in an existing spreadsheet, create a spreadsheet with rows, columns, headings)
Have at least basic computer operation skills: ................................................................. 99%
   (ability start up and shut down computer correctly, launch and quit an application, save & print a file)
Strongly agree or somewhat agree ................................................................................. 95.2%
   (skilled in using a computer to obtain information needed for academic research and class assignments)
Appendix D: References


