DOCUMENT RESUME

ED 402 901 IR 018 186

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TITLE	Meeting the Needs of CALS Students for Computing Capabilities. Final Report of the Ad Hoc Committee on College of Agriculture and Life Sciences Student Computing Competencies.
PUB DATE	Sep 96
NOTE	47p.
PUB TYPE	Reports - Evaluative/Feasibility (142)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Agricultural Education; Biological Sciences; Computer Attitudes; *Computer Literacy; Computer Software; Computer Uses in Education; Curriculum; Employment Qualifications; Graduation Requirements; Higher Education; Information Literacy; Internet; Introductory Courses; Job Skills; *Minimum Competencies; Noncredit Courses; Science Instruction; *Skill Development; *Undergraduate Students; *User Needs (Information); Workshops
IDENTIFIERS	Computer Use; *Cornell University NY

ABSTRACT

The Ad Hoc Committee on the Cornell University (New York) College of Agriculture and Life Sciences (CALS) Student Computing Competencies was appointed in the fall of 1995 to determine (1) what all CALS undergraduate students should know about computing and related technologies; (2) how the college can make it possible for students to develop these capabilities; and (3) the pros and cons associated with each of the identified options. The study also looked at the best means by which students can develop computing skills; the role formal assessment should play at the college level; and the implications for graduation requirements. The committee assessed the history and current state of computing within the CALS curriculum, and surveyed employers and faculty to find out the kinds of computing capabilities employers seek in graduates, and the opinions of "high-end" users of computing and related technologies on campus. Results of the assessment indicate that students should obtain a basic knowledge of major applications, particularly word processing and spreadsheet analysis, and have some experience with presentation software and database management software. Students also need to be able to demonstrate that they can effectively use the Internet by gathering and evaluating data from the Internet. In addition, all students should explore and utilize computing as it is used by professionals within their field of study, and upper level courses with significant computing content should be available in each major. Committee recommendations are discussed. Tables and figures show computer use data, attitudes about computers, computer use in courses offered, participation in non-credit workshops, a flow chart of introductory computer course relationships, and enrollment in CALS computer application courses. (Author/SWC)

Meeting the Needs of CALS Students for Computing Capabilities

Final Report of the Ad Hoc Committee on College of Agriculture and Life Sciences Student Computing Competencies*

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Edited and compiled by David Monk

August 12, 1996
Revised September 30, 1996

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Executive Summary

The Ad Hoc Committee on the College of Agriculture and Life Sciences (CALS) Student Computing Competencies was appointed in the fall of 1995 and has worked under the aegis of the CALS Office of Academic Programs. The Committee was asked to answer the following three questions:

1. What should all CALS students know about computing and related technologies?

2. What are the alternative means by which the College can make it possible for students to develop these capabilities?

3. What are the pros and cons associated with each of the identified options?

In addition, the Committee was asked to provide advice to the College about: (1) the best means by which students can develop computing skills; (2) the role formal assessment should play at the College level; and (3) the implications, if any, for graduation requirements.

The Committee began its work by collecting information about computing and related technologies within higher education in general and Cornell University in particular. Existing research was reviewed, a survey of employers was conducted, and a series of telephone interviews was conducted with members of the CALS faculty.

The Committee recommends that the College develop a computing graduation requirement and that it do so in a way that is sensitive to variation that exists in students' need for computing capabilities. The Committee believes that all CALS students should have the kind of familiarity with computing and related technologies that can be acquired in not-for-credit workshops and that each CALS student should be expected to augment this kind of workshop level of competency with at least one (1) credit-bearing experience that involves the substantive application of these technologies. The Committee distinguished between credit and non-credit bearing training on the basis of the degree of connection between the instruction and the parent discipline or area of application. A credit-bearing course needs to be able to demonstrate a clear connection with the offering Department's academic focus.

The Committee also recommends that responsibility for developing credit-bearing courses at a variety of levels of sophistication be vested with the individual Departments and Sections within CALS. In the Committee's view, the best role for the College to play involves providing the necessary resources to offer high quality instructional opportunities and monitoring Department and Section compliance with the expectation that courses be offered with modern technological content.

I. Introduction

Our committee was appointed in the fall of 1995 for the purpose of studying and making recommendations about the development of computing competencies for CALS undergraduates. We have been operating under the aegis of the Office of Academic Programs within CALS. Dean Sutphin appointed the membership of the committee and developed the charge that has guided our work.

Specifically, we have sought to answer the following three questions:

1. What should all CALS students know about computing and related technologies?

2. What are the alternative means by which the College can make it possible for students to develop these capabilities?

3. What are the pros and cons associated with each of the identified options ?

As we began our work, we quickly realized that it would be important for us to have an up-to-date assessment of where the College is with respect to the provision of instruction that involves the use of computers and related technologies. We initiated a study of College's curriculum that included a mailed survey of recruiters who come to campus to hire CALS graduates plus a telephone survey of faculty members within the College. The first major section of our report provides an overview of what we learned about the College's current offerings. Next, we report the results of the survey we conducted of employers where we sought information about the kinds of computing capabilities that are important to individuals who recruit graduates of the College. This discussion leads to a report of the faculty interviews that we conducted. The final sections deal explicitly with the three questions that have guided our inquiry in addition to our recommendations.

II. History and Current State of Computing Within the CALS Curriculum

Microcomputers gained widespread use in the early 1980's and have had a pervasive impact on the learning environment for both students and faculty in CALS. This section briefly describes some of the major trends regarding microcomputer usage, curricular requirements, for-credit course offerings, non-credit instructional / training efforts, and other impacts on the CALS collective learning environment that are related to microcomputers.

General History of Microcomputing and Instruction in CALS

Faculty computer use. During the last decade and a half computers have assumed an increasingly important role for College faculty and their students. A longitudinal study of the diffusion of computer technology among the Cornell faculty[1] documents some of these changes. In 1980, only half the faculty had ever used a computer. The advent of more powerful microcomputers quickly altered the picture. By 1986, 78% of Cornell faculty personally used a computer; median use was 12 hours per week while using programs from five major categories of computer applications. By late 1988, 88% of the faculty used computers for a median of 14 hours per week and 6 applications. By 1995 virtually all faculty (96%) used computers, spending a median of 19 hours per week at the keyboard while using programs for seven different applications (Table A). The greatest recent change has been in networked communication and data retrieval. Cornell faculty e-mail users more than doubled between 1988 and 1995 (rising from 43% to 96%), while users of on-line information retrieval more than tripled (rising from 26% to 84%).

As use increased, the perception grew that computers are indispensable for faculty work. In 1986, 39% of Cornell teaching faculty agreed with the statement "Without the use of computers, I could not complete the work which is expected of me." In 1988, 53% agreed; in 1995, 77% agreed. A growing number of faculty also agree that "undergraduate students in my discipline require substantial knowledge of computers in they are to successfully compete in the job market." Sixty percent agreed with this statement in 1988; 70% in 1995 (Table B).

Consistent with their belief that computers are indispensable for professional work, Cornell faculty use computers in instruction. However, their most frequent use is to support instruction delivered through other channels. Most faculty use computers to prepare written documents and presentation visuals for classes; about two-thirds use computers to maintain class records. Faculty are less likely to use computers as an instructional technology per se. Sixty percent report their students are required to use computers as a tool to complete assignments; 35% use a computer for in-class demonstrations, and 34% report their students use computer based exercises. Computer use in teaching has increased since 1988, but this change has not been dramatic (Table C).

The use of campus networks and Internet resources for instruction is just emerging. One fourth of the faculty report using the network in their courses during Fall semester 1995; an additional 35% express interest in using the net for classes. Instructional network uses are divided about equally between facilitating

[1] This study, conducted by Paul Yarbrough and his students (Yarbrough, 1987; Masiclat, 1991; and Wu, 1996), examines random samples of Cornell faculty in April 1986, November 1988, and September 1995. The term "faculty" was construed to include all individuals with tenure track appointments plus all those with appointments as lecturers, extension associates and research associates. Thus defined, the 1988 teaching faculty sample includes 286 persons (111 from CALS); the 1995 teaching faculty sample includes 243 persons (72 in CALS).

communication and acquiring information (Table D). Faculty report using several routines to increase communication among class members and to improve communication between students and the instructor. Several protocols have been used for information search and retrieval, but databases accessed throughout he World Wide Web and web "search engines" are emerging as the clear preference for Cornell classes.

CALS faculty are somewhat ahead of the rest of Cornell faculty in general computers uses and lead significantly in instructional support and Internet uses. This lead holds when academic discipline is controlled, and the lead was nearly the same in 1988 and 1995. Compared with the rest of Cornell's faculty, CALS faculty have consistently seen computers as more essential to their own professional role and to the careers of the undergraduates they teach.

<u>Student computer use</u>. Faculty computer use is only part of the evolving technological learning environment in CALS. Student computer use is the other. In order to describe some sense of student computing use, a study which analyzed computer use of Cornell freshman in the 1993-94 academic year was consulted (Sturgill, 1995). In brief, this study identified the following patterns of usage among 1993-94 Cornell freshman (the data reported below were collected in February, 1994):

- 66% of the students in the survey reported using e-mail at least once per week.
- About 38% of students in the survey reported using gopher at least once per week.
- About 24% of students in the survey reported using on-line library services at least once per week.
- About 29% of students in the survey reported using "Just the Facts" at least once per week.
- About 23% of students in the survey reported themselves as having either a "fair" or "very high" level of computer network experience.
- 63% of students in the survey reported owning their own computer, with 61% of this group having owned a computer for five years or more.
- 36% of students in the survey reported owning a modem.

- 57% of students in the survey agreed with the statement "I get more work done with the computer"; Sixty-seven percent agreed with the statement "Computers save time with work"; and 68% agreed with the statement "I need computer skills for my career."

- 83% agreed that "computer networks saved time in getting information", and 82% agreed that "computer networks are efficient for communication."

- 38% of students in the survey described themselves as "fairly" experienced with computers, while 13% described themselves as "very" experienced.

- Students in the survey reported that they used their own computer the most often (60%), a friend's computer (44%) followed by computers in a lab (43%), and the departments computers (16%).

- Students in the survey reported that used a friend's computer most often (51%) to access the network, followed by the library (49%), lab computers (48%), and their own computer (44%).

- Students reported using the following applications at least "moderately": word processing (91%); accessing the network (59%); playing games (39%); programming languages (24%); data analysis (23%); and graphics software (19%).

- The number of students in the survey who reported using their network accounts increased from 47% in September to 85% in February.

- An additional data source for the use of student computing is the annual computer ownership survey conducted by Cornell Information Technologies (CIT). Dumas (1994) found that 64% of incoming freshmen in 1994 reported owning a personal computer by mid-spring.

Microcomputing as Part of a University's Curriculum

National trends. Trends affecting informational technology use at Cornell are also affecting other institutions of higher education. In an effort to gather information on what is occurring at other institutions, an e-mail message was posted to two different, national listservs. The first listserv has approximately 4,000 subscribers, who are interested in issues related to higher education and technology. The second listserv has about 300 subscribers, most of whom are faculty members at major land grant institutions. Each listserv received a posting which described the general intent of this committee's work, and was asked if there were similar efforts or curricular requirements at other research institutions. A total of 14 responses were e-mailed in response to this general inquiry. A compilation of this data revealed:

> University of Nebraska-Lincoln Teacher's College--has an "electronic based" portfolio requirement (which demonstrates proficiency in computer applications) of students which must be completed by the student's junior year admission to a specific major. UNL Teacher's College is also developing a set of exit competencies for graduates.
>
> Virginia Tech College of Agriculture--has a 2-hour computer application course requirement for all students.
>
> Purdue University College of Agriculture--There is a 3-hour computer course requirement.
>
> University of Arizona College of Agriculture--A computer applications course is required.
>
> The University of Minnesota--has a general computer applications course requirement.
>
> The balance of respondents indicated that their institutions were also grappling with this issue, and seemed to be focusing on developing some sort of outcome expectations for students.

Computing requirements within Cornell academic units. Below we provide a list of existing computing requirements for graduation at Cornell for selected academic units. This list was compiled through a review of the 1995-96 Cornell Course of Study Guide. It is clear from the list that considerable variation exists across as well as within the major academic units at Cornell.

College of Agriculture and Life Sciences

CALS does not have a computing requirement for graduation. However, certain Departments have computing requirements:

Agricultural and Biological Engineering requires 4 credit hours (e.g., ABEN 151).

Agriculture, Resource, and Managerial Economics requires 3 credit hours in a programming or applications course.

Biometry and Statistics requires two courses (e.g., CS 100 & CS 211).

Horticultural Sciences encourages a course in computer science.

Natural Resources requires 3 credit hours in a programming or applications course.

Rural Sociology encourages a course in computer science.

Soil, Crop, and Atmospheric Sciences (SCAS) requires one course (for atmospheric sciences students).

College of Architecture, Art and Planning

Students are required to take 3 credit hours of visual studies that involve computer graphics plus a 3-credit hour course that deals with computer programming or applications.

College of Arts and Sciences

The College does not have a computing requirement for graduation.

Students may select Computer Science 100, 101, 172, 211, 212 as one of their choices for the distribution requirement for quantitative and formal reasoning.

In addition, certain Departments have computing requirements:

Astronomy encourages its students to acquire computer literacy skills.

Chemistry encourages its students to have an understanding of simple computer programming.

Computer Science -- (see College of Engineering).

Mathematics requires Computer Science 100 as a minimum and expects additional course work if the students selects a concentration in computer science.

Physics requires some knowledge about computing and encourages its students to take either Computer Science 99 or 101.

Science and Technology Studies requires two semesters of natural science or engineering (including computer science).

Geological Sciences students must take a course in either computer science or biological science or an intermediate-level course in biological science, mathematics, chemistry, or physics.

College of Engineering

The College of Engineering requires one 4-credit hour course in computer programming plus one additional course with a significant amount of computing applications

College of Human Ecology

The College of Human Ecology does not have a computing requirement for graduation.

Division of Biological Sciences

The Division of Biological Sciences does not have a computing requirement for graduation.

Division of Nutritional Sciences

The Division of Nutritional Sciences does not have a computing requirement for graduation.

School of Hotel Administration

The School of Hotel Administration requires one 3-credit hour course in microcomputing (HAdm 174)

School of Industrial and Labor Relations

The I&LR School does not have a computing requirement for graduation.

Computing requirements within CALS courses. In order to compile information related to computing used within current course offerings in CALS, we conducted a detailed review of the Course Descriptions contained in the 1995-96 Cornell Course of Study catalog. Course descriptions which contained either pre-requisites for computer courses, or contained reference to specific use of computers in some way were listed and sorted by both type of computer application/usage, and by Department. These lists were then circulated to Department and Section Chairs, who suggested revisions and provided updates to the lists as appropriate. This survey is presented in two tables, one (Table E) which shows courses sorted by department, and one (Table F) which shows the courses sorted by the type of use of computers.

Eighty four distinct courses were identified from this survey as having some form of instructional use of computing. This total does not include more ubiquitous types of computing uses, such as requirements for word processed papers or assignments, and it also does not include courses which utilize the campus network on an occasional basis. Courses on this list are those making intentional use of information technologies as some important part of the course curriculum. It is likely that this compilation is a somewhat conservative estimate of the overall use of computers in CALS courses.

Inter-connections among existing computer related courses. Figure 1 provides an overview of various routes CALS students can follow in their efforts to develop computing competencies through the use of formal courses. The figure depicts two dimensions (the level of mathematical sophistication and the level of programming sophistication). The figure makes it clear that the current curriculum provides multiple points of entry for students with a wide range of backgrounds and proficiency levels.

Since 1984 two CALS courses in particular, ABEN 102 and ED 247 (beginning in 1989), have provided entry level instruction in computers and their applications for Cornell students. The enrollment patterns for these courses has been strong over their combined history. Figure 2 describes these enrollment patterns.

Alternative (non-credit) Means of Obtaining Computing Competencies at Cornell

Workshops at Mann Library. Mann Library has conducted a large number of instructional, non-credit workshops for CALS students and faculty over the past 12 years (these workshops are open to the entire University community as well). Topics have included instruction in applications, use of on-line resources (especially, Mann Gateway resources), and the use of the Internet. These workshops have been consistently upgraded as technology has changed.

As Table G indicates, the number of workshop sessions per year has averaged more than 100 with average enrollments on the order of more than 2,000 participants per year. Table H provides insight into the composition of the participants and is based on a survey that was distributed during the spring and summer of 1996. It is clear that undergraduates were the least involved in the workshop series (their percentage share was between 9 and 13 percent), while graduate students were the most involved (their percentage share was between 55 and 56 percent). The reluctance of undergraduate students to participate in non-credit coureses is not unique to Cornell (Breivik, 1992). (Table H.)

Mann Library also instructs between 20 and 30 classes that support the needs of particular CALS classes. Most of these classes provide general overviews of the library and instruct students in the literature searching process. Often librarians are asked to present a topic to students in a large lecture hall. This has the effect of reaching more students but denies them the opportunity for hands-on practice. A high attendee rate should not be confused with effective pedagogy. Moreover, none of these large hands-off classes cover computer skills.

Workshops at CIT. Cornell Information Technologies (CIT) also operates a program of non-credit workshops on campus. Table I provides information about the number of participants in each type of workshop offered by CIT during the '94-'95 and '95-'96 academic year (Table I).

CIT has announced that it will no longer be offering software and operating system classes, effective during the summer of 1996. Workshops covering word processing, spreadsheets, data base management, and desktop publishing will no longer be offered.

III. Results of the Recruiter Survey

What Computer Skills do Employers Expect in Recent Cornell Graduates?[2]

Overview

A survey of Cornell recruiters of college graduates indicated that most employers consider computer skills important or very important in the hiring process. Basic word-processing, spreadsheet, and graphics/presentation software skills were all found to rank as the most important skills in a recent graduate. Employers responded very favorably to computer network skills – 93.3% expected e-mail experience, and 63.3% expected competency with online and Internet searching. Many skills were found to correlate with each other providing us with cross-functional groupings. C and C++ were identified as essential languages for programming positions.

Research Description

The College of Agriculture and Life Sciences is responsible for graduating students with the skills to thrive and lead in an ever-increasing technological environment. The purpose of Mann Library's research was to ascertain the computer skills employers felt necessary when recruiting recent Cornell college graduates. Our goal was to come up with a list of skills and to prioritize them based on the importance employers place upon them.

A questionnaire was created that asked employers to indicate the skill level expected from recent college graduates for 26 computer skills grouped into the following categories: 1) Importance of Computer Skills; 2) Creating Documents and Multimedia; 3) Working with Computer Programs; 4) Managing Databases; and 5) Manipulating Numeric Data. Two open-ended questions included 8) Other Computer Skills; and 9) Comments.

A mailing list containing the addresses of Cornell recruiters was obtained from the Career Center at Barnes Hall. The list included recruiters for all undergraduate colleges with the exception of the Hotel School.

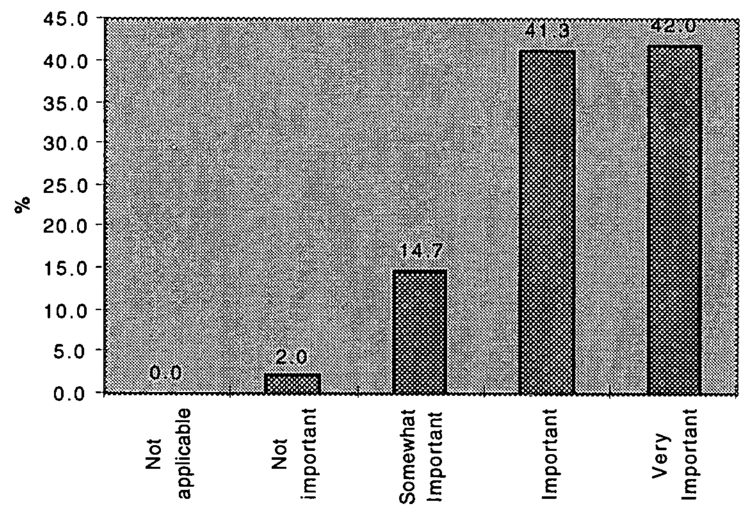
On January 26, 1996, nearly 300 questionnaires were sent. A second mailing, followed by a reminder letter, brought us a total of 150 usable returns (out of 295), representing a 51% response rate.

[2] This section was prepared by Philip Davis of the Mann Library staff. It is based on the results of a survey that was conducted by this committee thanks to the leadership of Jan Olsen.

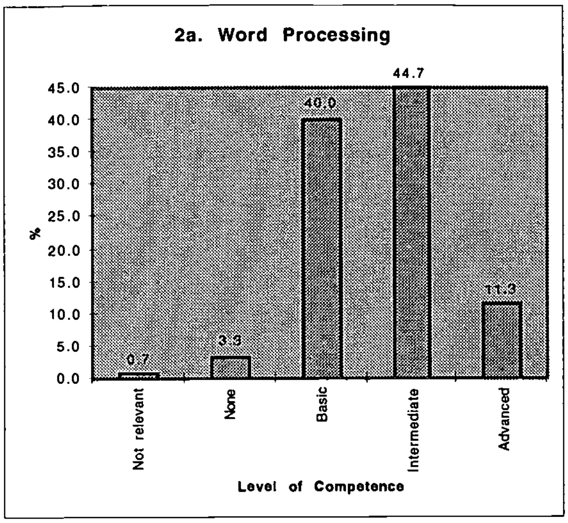
Observations

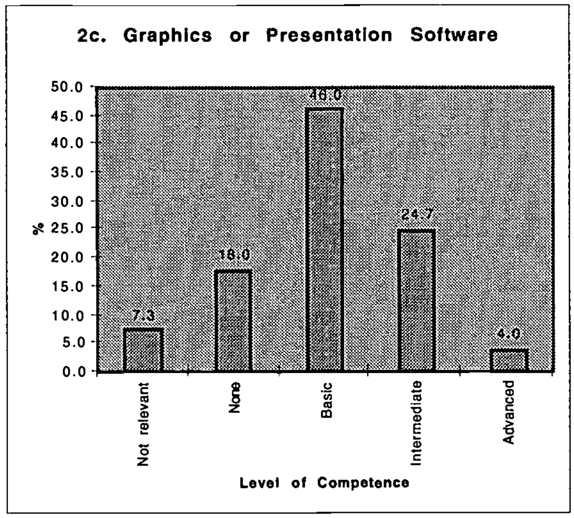
Generally employers have a high expectation of computer literacy in recent college graduates. A total of 83.3% indicated that computer competency skills are either 'important' or 'very important' in the hiring decision (Figure 1.).

1. Importance of Computer Skills in Hiring Decision

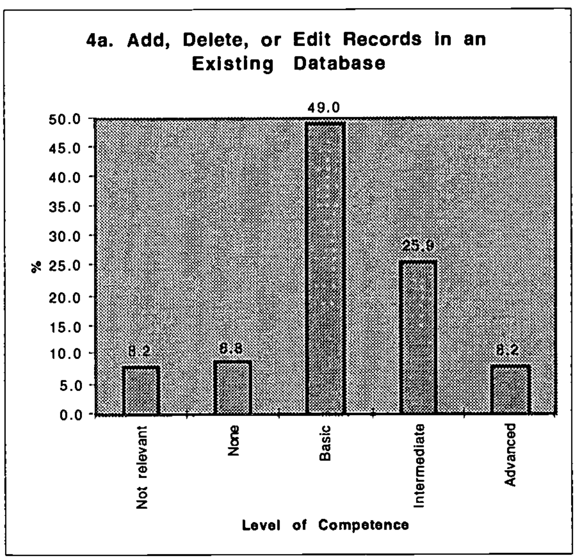


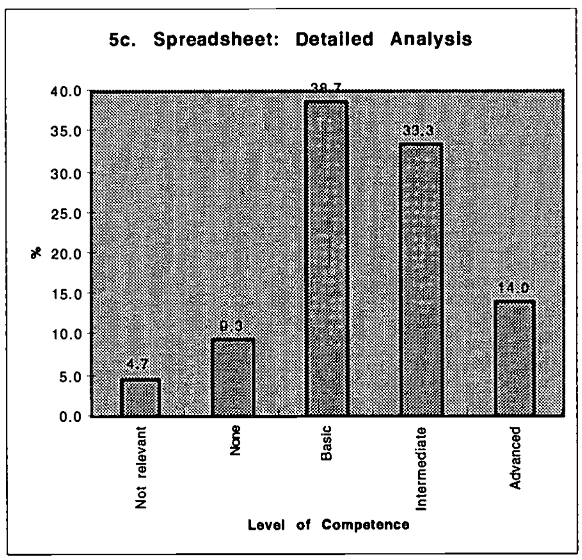
Within the Documents and Multimedia section, both Word Processing (2a) and Graphics or Presentation competency (2c) ranked highly compared to other skills. 96% of employers expected at least basic word processing skills, and 74.7% of employers expected at least basic graphics/ presentation software skills.



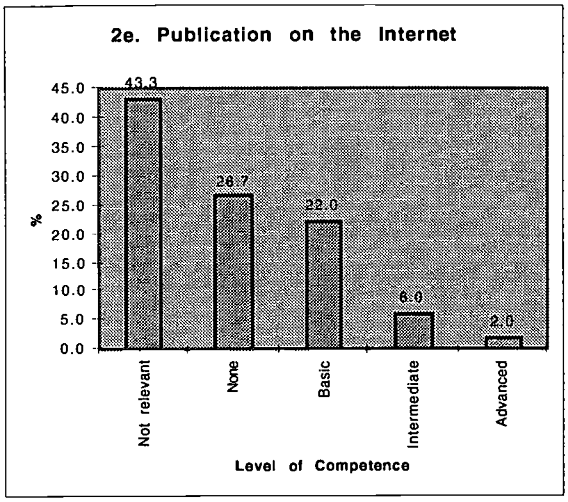


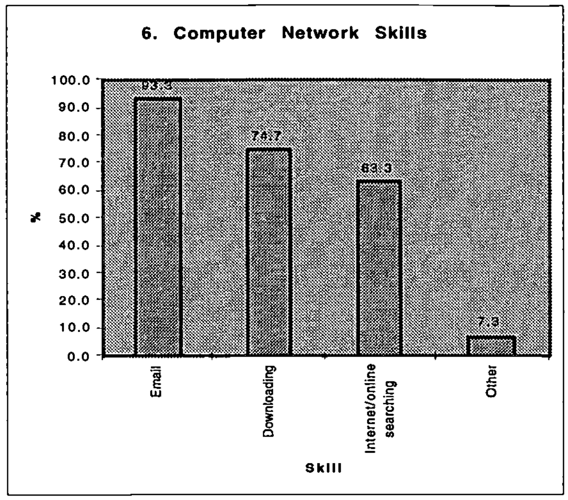
Skills from the Managing Databases section scored slightly lower, with basic database entry and editing skills (4a) coming out highest. Generally Numerical Data skills (and specifically spreadsheet skills) scored very high as a group. Even the ability to perform detailed analysis (5c) was expected by 86% of respondents.





Creating documents for publication on the Internet (2e) was ranked lowest compared to other computer literacy skills, with 70% of respondents indicating that no skills were expected, or that the question was irrelevant to the position. On the other hand, employers responded very favorably to Computer Network Skills (6). 93.3% expected e-mail experience, and 63.3% expected competency with online and Internet searching.

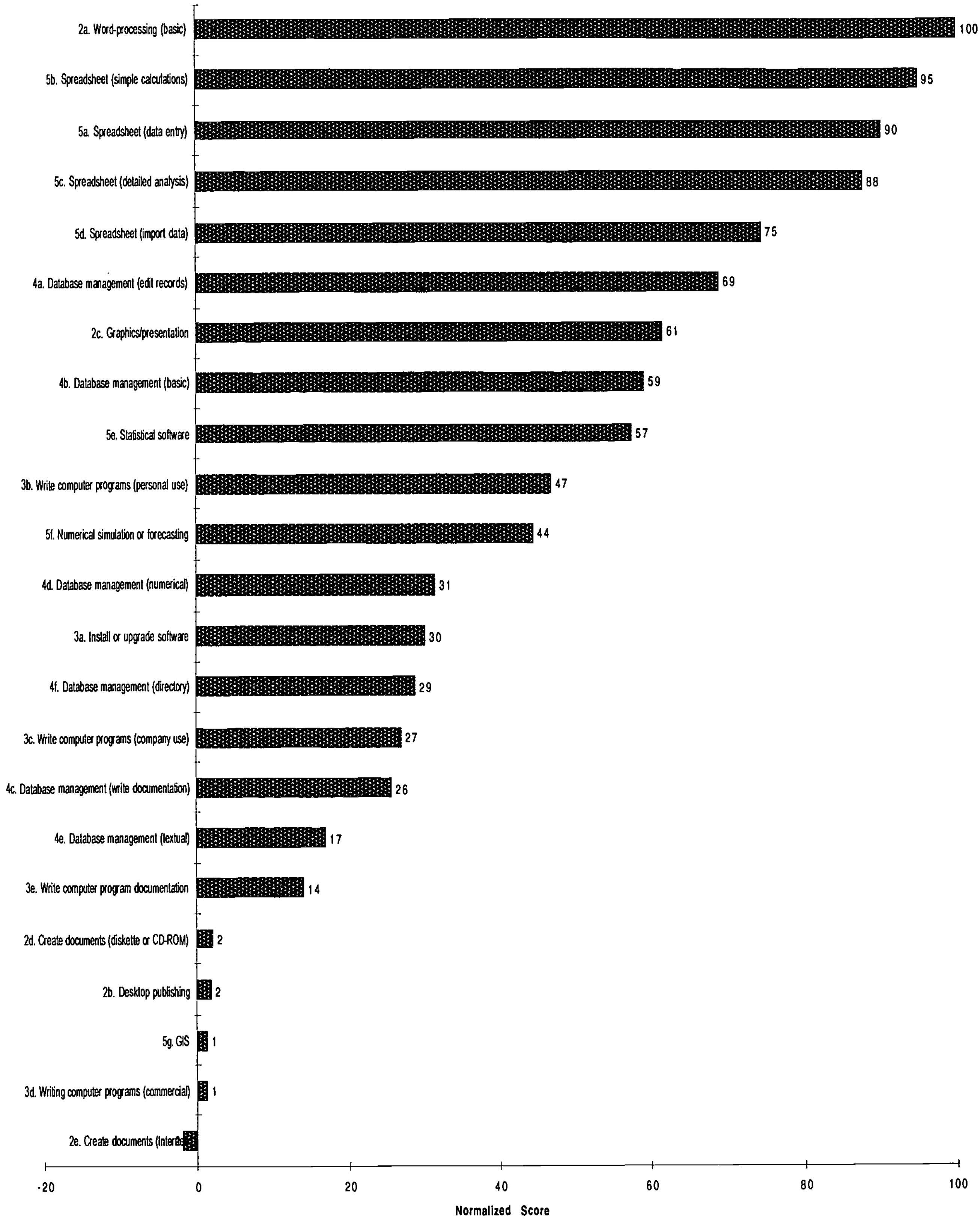




Ranking Computer Skills

The following diagram provides an overview of how all computer literacy skills are ranked with respect to each other. The maximum score for any skill was 100, given to word-processing
(2a).

Computer Skills Ranked by Normalized Score (N=150)



Grouping Computer Skills Together

Correlation analysis was performed with the goal of providing an overview of how individual computer competency skills are grouped together. Most skills were positively correlated with each other. This should be of no surprise since employers who place high importance on computer competency tend to rank most skills highly.

Generally, individual skills were highly correlated within each functional group. This was especially so within the Computer Programs, Managing Databases, and Numeric Data categories.

Across functional groups, word processing was highly correlated with basic and intermediate spreadsheet competency. Graphics/presentation skills was also highly correlated with spreadsheet skills. Basic and intermediate computer programming skills were correlated with most database management skills. And database management skills were correlated with advanced numeric data skills which include statistical analysis, mathematical modeling, and geographic information systems (GIS).

Other Computer Skills

Most employers used this open-ended question to list specific languages, programs or skills. The following table groups these responses. Those listing programming skills overwhelmingly mentioned C or C++ as a programming language.

Other Computer Skills (N=51)

Programming Language	frequency
C or C++	25
General programming skills	3
Basic/Visual Basic	2
PASCAL	2
FORTRAN	2
Perl	2
Assembly	2
Java	2
Ada	2
APL	1
Total	43

Database Programming	frequency
SQL	3
Oracle	2
Sybase	2
Other	3
General database programming	2
Total	12

Those listing specific operating systems made high reference to UNIX and the DOS/Windows platform.

Operating Systems	frequency
UNIX	9
DOS/Windows	6
Other	4
Total	19

Excluding word-processing and spreadsheet skills (which were analyzed in more detail in other parts of the questionnaire), Computer Aided Design (CAD) skills were listed most frequently.

Software (other than wp or spreadsheet)	
CAD	4
GIS	1
Statistical	1
Other	2
Total	8

Discussion

Although this study has helped us understand the kinds and proficiencies of computer skills sought by Cornell recruiters, we will need to speculate further on what the results mean to the College.

This study represents a static picture or "snap-shot" of what employers are looking for today; it does not predict what employers will be looking for in four years time when a new group of freshmen will be graduating. We were surprised to see that creating documents for the Internet (2e) was ranked last out of 23 skills; however, a group of industry experts might predict that this skill will become as important as basic word processing in the next few years.

Many of the respondents noted that "computer skill expectations vary depending on the department one joins". It would be a gross oversimplification to conclude that all entry-level positions, from customer service representative to systems analyst, are requiring the same set of computer skills.

IV. Results of Faculty Interviews

We conducted a series of telephone interviews with members of the CALS faculty. Our goal was to gain insights into the thinking of "high-end" users of computing and related technologies on campus. These interviews were not based on a random sample and the results should not be used to draw formal inferences to the larger population of faculty members.

Responses to Questions About What Students Need to Know

The faculty members we surveyed identified three basic areas of competency: a) the ability to make effective use of contemporary applications; b) the ability to reason effectively using data; and c) the ability to write computer programs. The following observations were offered about each of these three areas:

Applications. There seemed to be widespread agreement that every CALS student ought to have a basic understanding of the most fundamental applications of computing and related technologies. When asked to list the kinds of software that CALS students ought to be knowledgeable about, faculty members listed: wordprocessing, presentation (e.g., Powerpoint), spreadsheet analysis, database management, in addition to software with graphics capabilities. In addition, the faculty noted that students need to be familiar with the World Wide Web, electronic mail, and possess the ability to search for information on the Internet.

It also became apparent that some types of software are much more relevant to some majors (and some specialties within a given major) than others. For example, we found that the faculty members we spoke with in the Department of Natural Resources voiced interest in ensuring that their students were knowledgeable about GIS and Stella (a software program for computing population dynamics).

Thus, it seems reasonable to distinguish between a level of literacy that is relevant for all CALS students and a more differentiated level of skill that is built upon a common foundation.

Evaluation and reasoning skills. The faculty members we spoke with also emphasized the importance of having students be able to make sense of the information they are encountering thanks to the advent of computing and related technologies. There is some worry about students who understand the mechanics of searching a data base on the Web but who do so with little clue about what to do or how to evaluate the information that is gathered.

These are longstanding concerns that are hardly unique to computing technologies. Nevertheless, the rapid development of new information retrieval systems has perhaps elevated the concern in faculty members minds. As one member of the faculty put it:

> Students need to be able to use calculators and computers as intelligent tools for processing data, performing calculations, and solving problems. Cornell graduates will not be expected to work in isolated office settings with only paper and pencil as resources, and come up with answers in an hour or less. Therefore, it is reasonable and appropriate that they have opportunities, as students, to work on real problems, in real settings, with appropriate resources, and appropriate expectations.

This faculty member also commented eloquently on the potential for the new technologies to assist in College's efforts to develop these more fundamental reasoning skills:

> While able to demonstrate algebraic proficiency, students have underdeveloped problem solving, estimating and modeling skills. They also tend to have a one-dimensional view of mathematics, rather than a multi-representational view of the field that integrates graphical, algebraic, tabular, and linguistic representations of mathematical concepts. Computing software provides opportunities to students to work with multiple representations of concepts or multiple displays of information. The integration of these multiple representations leads to the deepening of their mathematical understandings. In addition to conceptual growth, there is a need to be competent in the use of technological tools. Students should be able to manipulate data tables, construct graphs, scale them appropriately, and make sound mathematical conclusions based on these representations, using computing software (e.g. Excel, Mathematica, MathCad, Function Probe). In addition, they should have the skill to use a word processor for writing out justifications, arguments, and explanations. Finally, students should be able to integrate written, graphical, and quantitative displays of their understandings.

Programming. Finally, the interest that was expressed in students developing programming skills (in contrast to application skills) was significant but much more localized. No one suggested that all students should receive even basic training in programming. There was a widespread recognition that programming skills are more specialized and are not the sort of thing that everyone needs to know.

Responses to Questions About How Best To Develop these Capabilities

The members of the faculty we interviewed drew a sharp distinction between basic or fundamental kinds of computing knowledge and capability and the more specialized kinds of skills that are important for particular majors. There appears to be consensus that all students should obtain a basic level of what might be called computer literacy, but that opportunities need to exist for students to go well beyond the basics depending on their interests and degree program.

The faculty members we spoke with also seemed convinced that the underlying reasoning skills are of the utmost importance and that efforts need to be made to guard against workshops and courses that simply teach applications with little effort to develop more fundamental problem solving skills.

Our interviews did not reveal consistent views from members of the faculty about the best mechanisms for developing these capabilities in students (e.g., workshops v. courses), although it was clear from a number of the comments that feelings about this question are sometimes strong. Here are some representative comments:

> There might be a credit or non-credit introductory (freshman) course or workshop.
>
> Students might be able to "test out" of a given competency.
>
> The College should provide a rigorous, credit based college course with structure, one much like ED 247 or ABEN 102.;
>
> There are certain discipline based requirements, that make some of these types of curricular decisions most appropriate for Departments to make.
>
> I would not support a course (credit) requirement. I would only support a non-credit based workshop.
>
> The days of credit based computer applications courses are gone. It's too hard to keep these courses up to date.
>
> Students learn these general skills best by doing them. I would not support a course based approach to basic skills. It would be better to invest the resources needed to teach an applications course into student lab assistants that staff all of the computer labs on campus.
>
> There should be a modified "help-desk" approach. The residence halls have invested in a "peer expert" approach to student assistance. In short, "beef up" the lab spaces with a more highly skilled student based staff (i.e., provide "on demand" assistance).

Rely on courses that maximize the use of information technologies to achieve curricular goals (e.g., ED 115).

Evaluation and reasoning skills are best taught and learned across the undergraduate curricular experience.

There is a need to learn to spend time and effort on developing these skills (evaluation and reasoning skills) throughout the Cornell experience, as well as to develop a familiarity with the discipline.

Other Relevant Issues that Surfaced

Curriculum articulation problems. Some faculty members expressed a concern over a perceived lack of continuity and use of programming skills between the freshman, sophomore, junior, and senior years. As a consequence, seniors tend to forget how to properly program and many do not feel comfortable with spreadsheets. Many instructors are reluctant to change their courses, to include the use of a "standard" set of software tools. One instructor suggested that software instruction be given to instructors so that these computing tools are used more in the sophomore and junior courses.

Advisability of a CALS computing requirement. The faculty members we interviewed were mixed in their opinion about having a CALS computing requirement. One suggested that courses include computing prerequisites, instead of a computing requirement. Another suggested that computing might be included with the math test for incoming freshmen or to waive the computing requirement if the student took adequate computing instruction in high school. If the student is deficient in computing skills, some formal computing course work might be required.

Challenge of staying current. Several of our interviewees commented on the fast paced nature of computing technologies. They stressed the importance of developing within students the ability for them to keep themselves current. These faculty members also noted the difficulties they face in their efforts to keep themselves up-to-date in the face of the other demands on their time and effort.

V. Responses to the Three Questions

Based on the findings reported above as well as the results of our own deliberations, we offer the following responses to the three questions that guided our inquiry.

1. What should all CALS students know about computing and related technologies?

The Committee developed the following statement concerning the components of Computing Proficiency:

All CALS students should graduate with a working knowledge of the following kinds of software: word-processing, presentation tools (e.g., Powerpoint), spreadsheet analysis, database management, and graphics. In addition, students need to be familiar with the World Wide Web, electronic mail, and possess the ability to search for and make effective use of information on the Internet. Students should be discerning consumers of data and information that can be gathered using electronic media, and need to develop the requisite evaluation and reasoning skills. Finally, all CALS students should be sufficiently comfortable with these technologies so that they can continue to acquire skills that will be necessary for them in their area of interest after they leave campus.

Careful examination of the above description reveals three major themes:

a. Obtaining a basic knowledge of major applications. The two most important applications for all students to have competencies are word-processing and spreadsheet analysis. Word-processing can be learned by most students on their own, however many students who learn on their own are not proficient at importing material from other applications or at creating tables. Spreadsheet analysis is the most important application for students to master. Many student projects can benefit from spreadsheet analysis and can provide valuable opportunities for students to display, analyze, and interpret data. Presentation software and database management software are also important applications with which students should have some experience.

b. Gathering and evaluating data and information from the Internet. All students need to explore resources available from the Internet. Most students need guidance on how to find important resources. All students should be able to demonstrate that they can effectively use these resources.

c. Computing in one's major. Students need to explore and utilize computing as it is used by professionals within their field of study. Upper level courses with significant computing content should be available in a student's major. These courses should challenge students to use their reasoning skills through the use of software tools.

2. What are the alternative means by which the College can make it possible for students to develop these capabilities?

We have identified the following mechanisms that can be relied upon by CALS to develop computing skills:

Non-Credit Workshops

Workshops on word-processing, spreadsheets, and searching the internet for information are offered through CALS by Mann Library. These workshops can be voluntary or required by instructors teaching courses in related areas. Workshops can be structured in a group format with leaders or they can be structured as pre-programmed tutorials.

Credit-Bearing Courses

The committee identified three types of credit bearing courses that can foster growth in students' understanding of computing:

(1) introductory application courses where the goal is to provide students with a solid foundation in Computing Proficiency.

Presently CALS offers two introductory courses that offer an overview of computer applications: ABEN 102 (Introduction to Microcomputer Applications) and ED 247 (Instructional/Informational Application of Microcomputers and Related Technologies). Both courses fulfill the objectives of computing proficiency for CALS graduates by exposing students to the all the basic software tools. Both courses have students engaged in a special project. ABEN 102 covers word-processing and spreadsheets in greater depth than ED 247, while ED 247 devotes more time than ABEN 102 to a special project. In ABEN 102 students choose a topic from their major, while ED 247 students select a topic related to education and/or information technologies.

(2) introductory programming courses teach analytical skills through a high-level language.

Two introductory programming courses are offered by CALS: ABEN 151 (Introduction to Computing) and ABEN 104 (Introduction to Programming using Pascal plus C++ or FORTRAN). ABEN 151 is a required computing course for ABEN majors. The focus of this course is to use programming to solve problems in agricultural and biological engineering, rather than teach students to meet the goals of computing proficiency, where students would be exposed to several productivity software packages and utilizing the internet for information retrieval. Nevertheless, ABEN 151 does expose students to the use of a computer as a productivity tool, to spreadsheets and to Matlab. Thus ABEN 151 does partially meet the goals of computing proficiency. ABEN 104, like CS100 and CS211, is strictly a programming course, where students learn to solve problems using programming tools. To reach all the goals of computing proficiency, students taking programming course will need to supplement their education with additional computing experience.

(3) more advanced courses where the focus is on applications that are relevant to a specific discipline.

In our review of the CALS curriculum we found a significant number of the more advanced courses using specific software applications. Some selected examples are:

SCAS 353	Application of Fortran in Meteorology
ARME 410	Business statistics (using Data Desk statistical application)
COMM 232	Art of Publication (using desktop publication software, PageMaker)

3. What are the pros and cons associated with each of the identified options?

Non-Credit Options

Advantages: The programs can be provided at relatively low levels of cost. They appear to be best suited for developing entry level skills that are not tied to particular disciplines or majors. Students can take a specific workshop to fill gaps in their computing proficiency, such as learning how to access data from the internet or learning how to use spreadsheets effectively.

Disadvantages: Students who need the skills the most tend to avoid the opportunities in part because there is no way to earn credit toward graduation. There is no easy way to assess student performance. The programs tend to be of short duration and risk being disjointed. An exclusive reliance on workshops would not expose students to all aspects of computing proficiency. For example, students taking only workshops would not be able to synthesize their computing skills into a project related to their major, something which is required of students in the introductory application courses.

Credit Options

a. introductory application courses:

Advantages: Students taking either ABEN 102 or ED 247 can fulfill their computing proficiency in a single course. In addition, these courses help those students at the low end of the skill continuum to catch up with those students at the higher end of the skill continuum.

Disadvantages: These courses are not appropriate for students who have developed computing skills. For some majors, such as Agricultural and Biological Engineering, a strong focus on programming is more appropriate.

b. introductory programming courses:

Advantages: Students taking an introductory programming course exercise their reasoning skills to a much greater extent than students taking an introductory applications course or workshops on productivity software.

Disadvantages: Introductory programming courses develop only a limited range of computing skills because they do not expose students to several important productivity software tools and because students are not typically expected to utilize information resources on the Internet.

c. advanced courses using specialized application software

Advantages: Specialized upper level courses such as SCAS 353, ARME 410, or COMM 232 provide in depth use of a specialized computer application targeted to a specific major, such as programming languages, statistical software, and desktop publishing, respectively. Students gain valuable insight in how computing proficiencies can be applied to their future profession.

Disadvantages: Advanced courses using specialized applications may not provide students with a well rounded exposure and practice with a wide range of productive tools required to achieve computing proficiency.

VI. Committee Recommendations

The Committee was asked to make recommendations to the College about the best mix of options to provide, the appropriateness of instituting a formal assessment mechanism, and the implications for graduation requirements.

Recommendations Concerning the Mix of Options to Provide

The Committee has concluded that all CALS students should have the kind of familiarity with computing and related technologies that can be acquired in not-for-credit workshops and that each CALS student should be expected to augment this kind of workshop level of competency with at least one (1) credit-bearing experience that involves substantive applications of these technologies. The Committee distinguished between credit and non-credit bearing instruction on the basis of the degree of connection betweeen the instruction and the parent discipline or area of application. A credit-bearing course needs to be able to demonstrate a clear connection with the offering Department's academic focus.

The following options should be available to students as they seek to fulfill the expectation that they enroll in at least one (1) credit bearing course:

a. Take a credit course where the emphasis is on a wide range of applications that are relevant to a particular discipline (e.g., ABEN 102 or ED 247). These courses need to maintain strong links to the substantive concerns of whatever Department or Section offers the course.

b. Take a credit course in computer programming (e.g., ABEN 151), provided it exposes students to spreadsheets and other major productivity software. The course should also expose students to data and information gathering over the Internet.

c. Take an upper level course using specialized software, but care needs to be exercised to ensure that students choosing this option do not develop gaps in their backgrounds. Workshops and/or introductory application courses can be helpful to these advanced students who wish to acquire breadth in their computing backgrounds.

Of course, many students will take more than one course beyond the workshop-level of instruction. It would also be desirable to provide students with the option of petitioning for an exception to the one (1) course requirement on the grounds that they have established an appropriate level of computing competence in some alternative fashion. These students could show work they have done where it is clear that basic software and Internet tools have been appropriately applied. These petitions would need to be judged on a case-by-case basis.

Recommendations Concerning the Role of Formal Assessment

The Committee debated the wisdom of recommending that the College develop a competency exam that could test for basic computing capabilities. We have concluded that it would not be wise for the College to develop such an assessment instrument. There are two primary reasons for this conclusion: (1) The exam would be difficult to develop and virtually impossible to keep up-to-date; and (2) Entering CALS students vary enormously in their entry level skills and taking a competency exam would be a waste of time for the many students who enter with well developed computing skills. We think it is wiser for the College to rely upon the Departments and instructors of courses that require computing capabilities to assess the computing competence of individual students.

Recommendations Concerning Graduation Requirements

The Committee has concluded that the College should impose a computing requirement for graduation. We have been impressed with the need for computing skills in virtually all areas of prospective employment. We also see computing literacy as being an increasingly important part of the lives of all educated people. We hope that the findings we present in this report will be helpful to the College if it chooses to develop a computing requirement.

However, we do not recommend establishing a conventional CALS graduation requirement that would require students to take specific courses. We think it is preferable to vest responsibility for monitoring the College's computing graduation requirement in the Departments and majors and ask each to develop a plan that would be reviewed periodically by the College. We think it is the College's responsibility to articulate what it expects its graduates to know about computing. Toward this end, we propose the following language:

> The College of Agriculture and Life Sciences expects all of its graduates to be proficient in the use of computing and related telecommunication technologies. Students can fulfill this requirement by succeeding in course work related to their chosen field of study that makes substantive use of computing and related technologies.

We hope our findings, conclusions, and recommendations are useful to the College as it seeks to improve its instructional program. It has been a privilege for us to serve on this committee and we look forward to the future debate about how best to meet CALS students' need for computing capabilities.

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VII. References

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VIII. Tables and Figures

Table A
General Indices of Computer Use Among Cornell and CALS Teaching Faculty, 1988 and 1995

	1988		1995	
	Cornell Faculty*	CALS Faculty	Cornell Faculty	CALS Faculty
Use computer any location	88%	9%	96%	97%
Median hrs/week use computer	14 hrs.	14 hrs.	19 hrs.	20hrs.
Median # applications used	5 apps	5 apps	7 apps	7 apps
Use e-mail	43%	45%	96%	100%
Retrieve on-line information	26%	31%	84%	89%

*Faculty with teaching responsibilities, includes CALS faculty sample.
Source: Adapted from Masiclat (1992) and Wu (1996).

Table B
Attitudes About Computers:
Cornell and CALS Instructional Faculty,
1988 and 1995

	1988		1995	
Statement	Cornell Faculty*	CALS Faculty	Cornell Faculty	CALS Faculty
Without the use of computers I cannot complete the work expected of me	53%	56%	77%	83%
Undergraduate students in my discipline require substantial knowledge of computers if they are to successfully compete in the job market	60%	75%	70%	85%

Source: Adapted from Masiclat (1992) and Wu (1996).

Table C
Cornell and CALS Teaching Faculty's Use of Computers for Instruction, 1988 and 1995

	1988		1995	
	Cornell Faculty*	CALS Faculty	Cornell Faculty	CALS Faculty
Instructional Support Applications				
Median hrs/week use computer	14 hrs	14 hrs.	19 hrs.	20 hrs.
Median # applications used	5 apps	5 apps	7 apps	7 apps
Use e-mail	43%	45%	96%	100%
Retrieve on-line information	26%	31%	84%	89%
Direct Use for Instruction				
Students use computers as a tool to complete assignments	44%	48%	60%	58%
Instructor uses computer for in-class demonstrations	27%	40%	35%	40%
Students use computerized auto-tutorial exercises	22%	25%	34%	32%
Mean Total Use for instruction	6.8	7.6	8.3	9.0

full-scale: 0-18
Source: Adapted from Masiclat (1992) and Wu (1996).

Table D
Cornell and CALS Teaching Faculty's Use of Internet Resources for Instruction, 1995.

Application	1995 Cornell Faculty	1995 CALS Faculty
Current Network Status		
Currently use network in my courses	31%	26%
Don't use now, but am interested in using	33%	35%
Don't use now, not interested in using	36%	40%
Network Communication Applications		
Use e-mail	27%	17%
Use mailing lists (listservs)	11%	5%
Use Usenet (newsgroups)	1%	1%
Network and Retrieve Applications		
World Wide Web	21%	16%
Gopher	10%	5%
File Transfer Protocols	6%	5%

Source: Adapted from Masiclat (1992) and Wu (1996).

Table E

COLLEGE OF AGRICULTURE AND LIFE SCIENCES--Computer Use in Courses

AGRICULTURE AND BIOLOGICAL ENGINEERING

REQUIRED: computer applications (programming) 4 credits

	ABEN	course title	prerequisites	in class use
x	102	Introduction to Microcomputer Applications		applications: WP, SS, DB, PG
x	104	Intro Prog using Pascal plus C++ or FORTRAN		programming: Pascal plus C++ or FORTRAN
x	151	Intro to Computing		programming: Pascal
	301	Intro to Energy Systems		extensive use of spreadsheets
x	371	Hydrology and the Environment		use computer programming
x	450	Instrument Design	programming / spreadsheets	personal computers
x	453	Computer-Aided Engineering	programming	math computation / computational software
x	454	Physiological Engineering	programming	computer applications
x	475	Environmental Systems Analysis	programming	computer simulations
x	481	Design of Wood Structures		computer-aided procedures
x	482	Bioenvironmental Engineering		students develop computer models
	671	Analysis of Flow of Water and Chemicals in Soils		computer-based techniques discussed
x	678	Nonpoint Source Models	programming	simulation models

AGRICULTURE, RESOURCE, AND MANAGERIAL ECONOMICS

REQUIRED: 3 credits of programming or computer applications

	ARME	course title	prerequisites	in class use
x	100	Introduction to Global Economic Issues		computerized financial markets
x	221	Financial Accounting		Internet and databse sources of information
x	302	Farm Business Management		spreadsheets
x	310	Introductory Statistics		statistical packages
x	313	Information Systems and Decision Models	ABEN 102 or equiv	computer models
x	323	Managerial Accounting		spreadsheets
x	324	Financial Management	computer skills preferred	analyzing financial problems
x	325	Personal Enterprise and Small Business Management		Internet research
x	405	Farm Finance		spreadsheets
x	410	Business Statistics		statistical packages
x	411	Introduction to Econometrics		forcasting software and modeling
x	412	Intro to Mathematical Programming		integer & non-linear programming
x	425	Small Business Management Workshop		Internet research
x	608	Production Economics		forcasting software, and econ.

				problems
x	641	Commodity Futures Markets		statistical computing
x	710	Econometrics I		statistical software
x	712	Quantitative Methods		nonlinear programming

ANIMAL SCIENCE

NONE REQUIRED

	AN SC	course title	prerequisites	in class use
x	312	Applied Cattle Nutrition		computer models
x	322	Applied Animal Genetics--Laboratory		uses CAI package
x	360	Beef Cattle		computerized simulations
x	420	Quantitative Animal Genetics		MatLab

BIOMETRY AND STATISTICS

REQUIRED: 2 computer courses (e.g., COM S 100 and COM S 211 -- programming courses)

	BTRY	course title	prerequisites	in class use
	101	Intro to Biometry I		computing using Maple or Mathematica
	102	Intro to Biometry II		use of computing in biol sciences
x	200	Statistics in the World We Live In		statistical computing
x	215	Introduction to Statistical Methods		statistical computing
x	408	Theory of Probability		statistical applications
x	451	Mathematical Modeling of Populations		computer simulations / mathematical packages
x	601	Statistical Methods I		MINITAB statistical software
x	602	Statistical Methods II		MINITAB & SAS statistical software
x	604	Statistical Methods IV		computer for design and analysis
	662	Mathematical Ecology		simulation techniques
x	717	Linear Models		computing
x	718	Variance Components		computer package output

COMMUNICATION

NONE REQUIRED

	COMM	course title	prerequisites	in class use
x	230	Visual Communication		some exposure
x	232	Art of Publication		desktop publishing
	285	Communication in Life Sciences		lab notes on World Wide Web
x	382/682	Methods of Communication Research		SPSS statistical package
x	439	Interactive Multimedia: Design and Research Issues		multimedia technologies
x	426/626	Impact of Commnication Technologies		computer-based information systems
	440/640	Social Design of Communication Systems		design of computer interfaces and software
x	639	Interactive Multimedia: Design and Research Issues		multimedia technologies

EDUCATION

NONE REQUIRED: Department provides instruction on applications of microcomputers.

	EDUC	course title	prerequisites	in class use
x	005	Basic Review Mathematics		Function Probe© math software
x	115	Introductory College Mathematics		Function Probe© math software
x	210	Psychology of Learning and Memory		required use of microcomputers
x	247	Instructional/Informational Application Micros		various applications
x	403	Observing and Teaching Science and Math		various applications
	647	Instructional Technologies: Analysis and Practices		instructional computing
x	762	Research in Educational Administration		statistical packages on mainframe

ENTOMOLOGY

NONE REQUIRED:

	ENTOM	course title	prerequisites	in class use
	444	Integrated Pest Management		application of computing technologies
x	453	Principles and Practice of Historical Biogeography		computer applications in lab
x	463	Invertebrate Pathology		computer simulations

FOOD SCIENCE

NONE REQUIRED:

	FOOD	course title	prerequisites	in class use
x	210	Food Analysis		various applications
x	321	Food Engineering		spreadsheet software

HORTICULTURAL SCIENCES

NONE REQUIRED: Floriculture and Ornamental Horticulture -- encourage students to take a course in computer science

	HORT	course title	prerequisites	in class use
x	413	Computer-Assisted Management in Control Env. Ag.		software for operations managment
x	415	Principles and Practices of Agroforestry		computer based sources of information

INTERNATIONAL AGRICULTURE

LANDSCAPE ARCHITECTURE

	LA	course title	prerequisites	in class use
x	410	Computer Applications in Landscape Architecture		will use AutoCad, Landcad, GIS

NATURAL RESOURCES

REQUIRED: One course in computer applications or programming -- 3 credits

	NTRES	course title	prerequisites	in class use
x	104	Natural History Concepts and Applications		multimedia
x	204	Natural Resource Modeling Concepts and Applications		modeling
x	304	Wildlife Species Ecology		computer-based information processing

x	253	Applied Ecology		spreadsheets
x	404	Wildlife Population Concepts and Applications	programming	programming for modeling
x	410	Wildlife Management Concepts & Applications		computer simulations of management problems
x	415	Principles & Practices of Agroforestry (HORT 415)		computer based sources of information

PLANT BIOLOGY

	PL BIO	course title	prerequisites	in class use
x	242	Plant Biology Laboratory		data collection and analysis of laboratory exp.
x	342	Plant Biology Laboratory		data collection and analysis of laboratory exp.

PLANT BREEDING

	PL BR	course title	prerequisites	in class use
x	717	Quantitative Genetics in Plant Breeding		computing quantitative genetic parameters

PLANT PATHOLOGY

	PL PA	course title	prerequisites	in class use
x	444	Integrated Pest Management		computer technology for management problems

RURAL SOCIOLOGY

NONE REQUIRED: encourage students to complement courses in computing

	R SOC	course title	prerequisites	in class use
x	213	Social Indicators, Data Management, and Analysis		data management & analysis using PCs
x	618	Research Design I		Extesive use of computers for data processing
x	619	Research Design II		Extesive use of computers for data processing
x	718	Multidimensional Measurement & Classification		Computers used to analyze fit to models
x	719	Logistic and Log Linear Models		Computerized labs an integral part of course

SOIL, CROP and ATMOSPHERIC SCIENCES

REQUIRED: one semester course in computer science.
(note: G. Fick reports this as a "strong recommendation . .not a requirement? dp)

	SCAS	course title	prerequisites	in class use
x	353	Application of Fortran in Meteorology	computer programming	numerical techniques using Fortran
x	371	Hydrology and the Environment (ABEN 371)		computer programs are used
x	420	Intro to Geographic Information Systems		experience with GIS for diverse applications
x	620	Applications of Geographic Information Systems	experience with DOS	modelling and databases

Table F
COURSES IN CALS WITH COMPUTING SORTED BY TYPE OF USE (total of 84 individual courses):

COURSES ON COMPUTER APPLICATIONS

ABEN 102	Introduction to Microcomputer Applications	applications: WP, SS, DB, PG
EDUC 247	Instructional/Informational Application Micros	various applications

COURSES ON PROGRAMMING

ABEN 104	Intro to Programming using Pascal and FORTRAN	programming: Pascal FORTRAN
ABEN 151	Intro to Computing	programming: Pascal

COURSES WITH PROGRAMMING OR COMPUTER APPLICATIONS PREREQUISITES

ABEN 450	Instrument Design	programming prerequisite
ABEN 453	Computer-Aided Engineering	programming prerequisite for mathematical computation
ABEN 454	Physiological Engineering	programming prerequisite for computer applications
ABEN 475	Environmental Systems Analysis	programming prerequisite for computer simulations
ABEN 678	Nonpoint Source Models	programming prerequisite for simulation models
SCAS 353	Application of Fortran in Meteorology	programming prerequisite for numerical techniq (Fortran)
ARME 413	Information Systems and Decision Models	applications prerequisite for computer models
NTRES 404	Wildlife Populations Concepts and Applications	programming prequisites for modeling
SCAS 620	Applications of Geographic Information Systems	experience with DOS for modelling and databases

COURSES THAT USE COMPUTERS IN CLASS/LAB: Statistical packages

ARME 310	Introductory Statistics	Data Desk statistical application
ARME 410	Business Statistics	Data Desk statistical application
ARME 411	Introduction to Econometrics	Micro TSP or EVIEWS
ARME 608	Production Economics	EVIEWS
ARME 641	Commondity Futures Markets	Limited statistical computing
ARME 710	Econometrics I	SAS statistical package
BTRY 215	Introduction to Statistical Methods	statistical computing
BTRY 408	Theory of Probability	statistical applications
BTRY 601	Statistical Methods I	MINITAB statistical software
BTRY 602	Statistical Methods II	MINITAB & SAS statistical software
COMM 382	Methods of Communication Research	SPSS statistical package
BTRY 642	Advanced Math Methods in Biometry & Stat	MACSYMA
EDUC 762	Research in Educational Administration	SPSS statistical package
FOOD 331	Statiscal Quality Control of Food Processing	statistical software

COURSES THAT USE COMPUTERS IN CLASS/LAB: Mathematical packages

AN SC 420	Quantiative Animal Genetics	MatLab
ARME 608	Production Economics	DERIVE or MATHCAD
EDUC 005	Basic Review Mathematics	Function Probe© math software
EDUC 115	Introductory College Mathematics	Function Probe© math software
BTRY 200	Introduction to Biometry	Maple or Mathematica used

COURSES THAT USE COMPUTERS IN CLASS/LAB: Spreadsheets

ARME 302	Farm Business Management	spreadsheets
ARME 323	Managerial Accounting	spreadsheets
ARME 405	Farm Finance	spreadsheets
ARME 410	Business Statistics	spreadsheets
NT RES 253	Applied Ecology	spreadsheets
FOOD 321	Food Engineering	spreadsheets

COURSES THAT USE COMPUTERS IN CLASS/LAB: Programming

ABEN 371	Hydrology and the Environment	use computer programming
ARME 412	Intro to Mathematical Programming	integer & non-linear programming
ARME 712	Quantitative Methods I	nonlinear programming

COURSES THAT USE COMPUTERS IN CLASS/LAB: Modelling

ABEN 482	Bioenvironmental Engineering	students develop computer models
AN SC 312	Applied Cattle Nutrition	computer models
AN SC 360	Beef Cattle	computerized simulations
ARME 411	Introduction to Econometrics	conometric modelling
ARME 608	Production Economics	solutions to economic problems
BTRY 451	Mathematical Modeling of Populations	computer simulations
BTRY 604	Statistical Methods IV	computer for design and analysis
NTRES 204	Natural Resource Modeling Concepts and Applications	computer models
R SOC 718	Multidimensional Measurement & Classification	Computers used to analyze fit to models

COURSES THAT USE COMPUTERS IN CLASS/LAB: Management

ARME 302	Farm Business Management	farm accounting, dairy farm business anal., and decision making
ARME 413	Information Systems and Decision Models	management and decision model software
ARME 324	Financial Management	analyzing financial problems
ARME 325	Personal Enterprise and Small Business Management	Internet research
ARME 405	Farm Finance	financial analysis of business
ARME 425	Small Business Management Workshop	Internet research
PL PA 444	Integrated Pest Management	computer technology for management problems
HORT 413	Computer-Assisted Manag Control Env. Ag.	software for operations managment
R SOC 213	Social Indicators, Data Management, and Analysis	data management & analysis using PCs
NTRES 410	Wildlife Management Concepts &	computer simulations of management

	Applications	problems

COURSES THAT USE COMPUTERS IN CLASS/LAB: General computing use

ABEN 481	Design of Wood Structures	computer-aided procedures
ARME 100	Introduction to Global Economic Issues	computerized financial markets
AN SC 322	Applied Animal Genetics: Laboratory	CAI package
BTRY 717	Linear Models	computing
BTRY 718	Variance Components	computer package output
COMM 230	Visual Communications	some exposure
COMM 354	Print Media Laboratory	will use microcomputers
COMM 356	Print Media Laboratory	will use microcomputers
EDUC 210	Psychology of Learning and Memory	required use of microcomputers
EDUC 403	Observing and Teaching Science and Math	various applications
ENTOM 463	Invertebrate Pathology	computer simulations
COMM 402	Advanced Argumentation and Debate II	computer-aided case research
COMM 626	Impact of Commnication Technologies	computer-based information systems
ENTOM 453	Principles and Practice of Historical Biogeography	computer applications in lab
FOOD 210	Food Analysis	various applications
PL BR 717	Quantitative Genetics in Plant Breeding	computing quantitative genetic parameters
R SOC 719	Logistic and Log Linear Models	Computerized labs an integral part of course
SCAS 371	Hydrology and the Environment (ABEN 371)	computer programs are used

COURSES THAT USE COMPUTERS IN CLASS/LAB: Desktop Publishing

COMM 232	Art of Publication	desktop publishing

COURSES THAT USE COMPUTERS IN CLASS/LAB: Multimedia

ARME 325	Personal Enterprise and Small Business Management	multimedia technologies
COMM 439	Interactive Multimedia: Design and Research Issues	multimedia technologies
COMM 639	Interactive Multimedia: Design and Research Issues	multimedia technologies
NTRES 104	Natural History Concepts and Applications	multimedia

COURSES THAT USE COMPUTERS IN CLASS/LAB: AutoCad

LA 410	Computer Applications in Landscape Architecture	will use AutoCad, Landcad, GIS

COURSES THAT USE COMPUTERS IN CLASS/LAB: Information Systems and Data Processing

ARME 221	Financial Accounting	Internet and database sources of

		information
ARME 413	Information Systems and Decision Models	information processing and analysis
HORT 415	Principles and Practices of Agroforestry	computer based sources of information
NTRES 304	Wildlife Species Ecology	computer-based information processing
NTRES 410	Wildlife Managment Concepts and Applications	computer based information processing
NTRES 415	Principles & Practices of Agroforestry (HORT 415)	computer based sources of information
SCAS 420	Intro to Geographic Information Systems	experience with GIS for diverse applications
R SOC 618	Research Design I	Extesive use of computers for data processing
R SOC 619	Research Design II	Extesive use of computers for data processing

COURSES THAT USE COMPUTERS IN CLASS/LAB: data collection and data anlysis from laboratory instruments

PL BIO 242	Plant Biology Laboratory	data collection and anlaysis in labs
PL BIO 342	Plant Biology Laboratory	data collection and analysis in labs

Table G
Participation in Mann Library Instructional Programs

Year	Sessions	Attendees
84-85	60	1129
85-86	115	2039
86-87	123	2155
87-88	113	3454
88-89	107	2910
89-90	80	2258
90-91	104	2602
91-92	124	1623
92-93	141	1728
93-94	144	1812
94-95	118	2156
95-96	131	1350
Total	1,360	25,216
Average	113	2,101

Source: Phil Davis memorandum, August 21, 1996.

Table H
Registrants by Status: Mann Library Workshop Series

	Undergraduate	Graduate	Faculty	Staff
Spring 1996	13%	56%	8%	24%
Summer 1996	9%	55%	12%	24%

Source: Phil Davis memorandum, August 21, 1996.

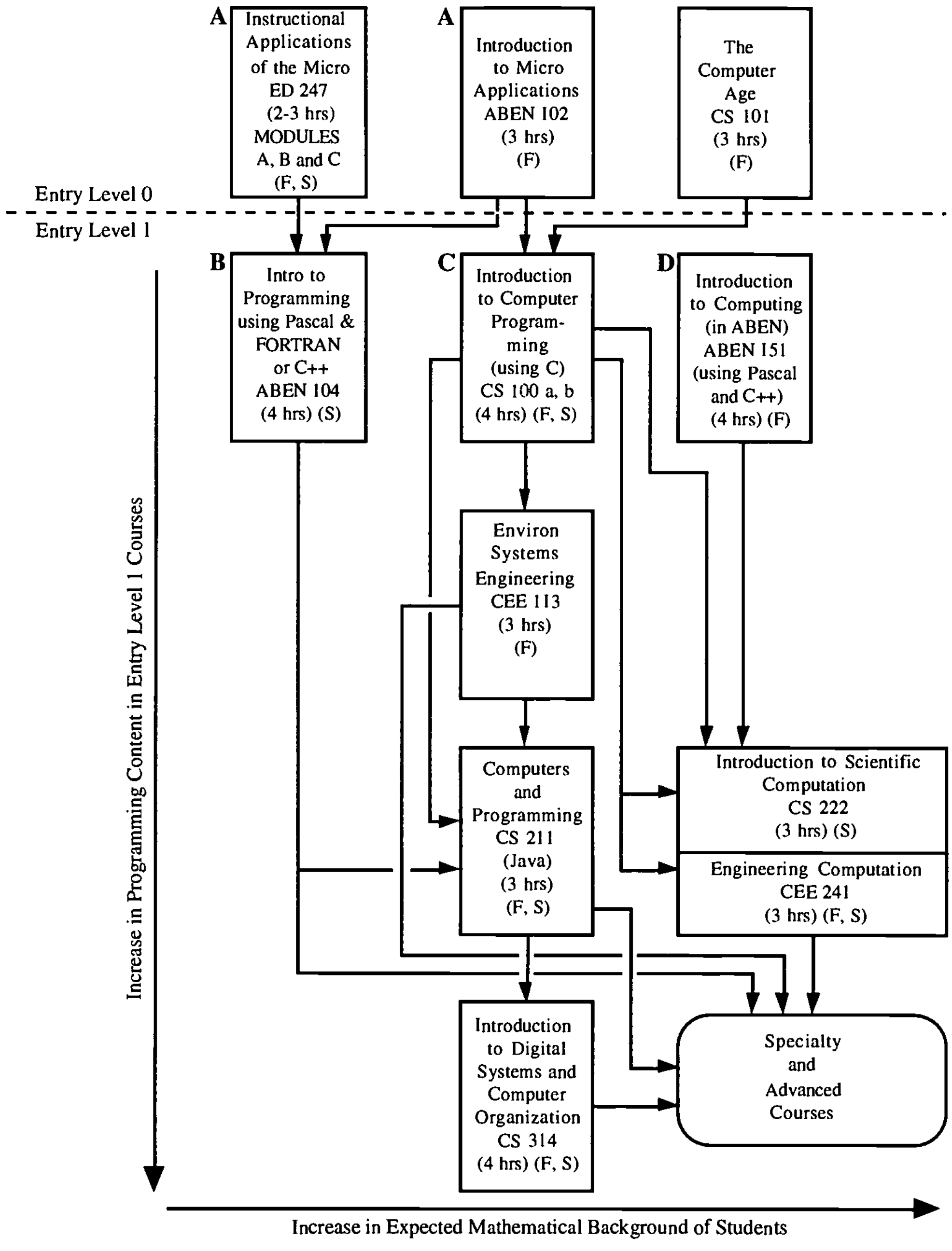
Table I
Counts of Participants in CIT's Workshop Series

	Spreadsheet	Database	Word Proc	Networks	OpSystems	Document Publishing
Fall '94	66	47	37	37	165	33
Spring '95	121	82	96	40	204	40
Fall '95	71	59	58	16	107	27
Spring '96	100	73	68	70	141	23

Source: Phil Davis memorandum, August 21, 1996.

45

Figure 1
INTRODUCTORY COMPUTER COURSE RELATIONSHIPS



KEY:

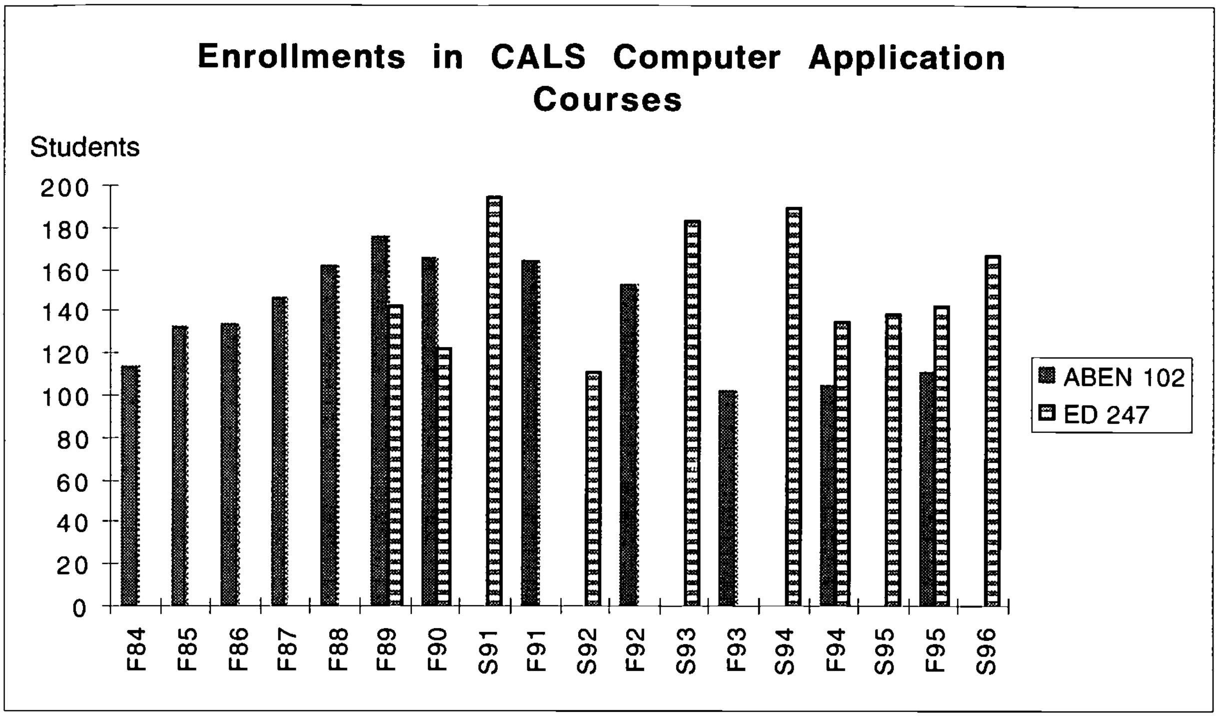
A. Recommended for students who are unfamiliar with computers.

B. Recommended for applied economics, business management, social and biological science majors (calculus not required).

C. Required for engineers.

D. Required for Agr. and Bio. Eng. majors; recommended for biological and physical science majors.

Figure 2.



Enrollments in CALS Computer Application Courses
Students
200
180
160
140
120
100
80
60
40
20
0
F84
F85
F86
F87
F88
F89
F90
S91
F91
S92
F92
S93
F93
S94
F94
S95
F95
S96
ABEN 102
ED 247

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