TOEFL®

Monograph Series

MS - 12
MARCH 1998

Computer and Communications Technologies in Colleges and Universities in the Year 2000

Eric G. Hansen

Candice K. Willut

ETS™ Educational Testing Service

Computer and Communications Technologies in Colleges and Universities of the Year 2000

Eric G. Hansen
Candice K. Willut

Educational Testing Service
Princeton, New Jersey
RM-97-6

Educational Testing Service is an Equal Opportunity/Affirmative Action Employer.

To obtain more information about TOEFL products and services, use one of the following:

E-mail: toefl@ets.org

Web site: http://www.toefl.org

Foreword

The TOEFL® Monograph Series features commissioned papers and reports for TOEFL 2000 and other Test of English as a Foreign Language program development efforts. As part of the foundation for the TOEFL 2000 project, a number of papers and reports were commissioned from experts within the fields of measurement and language teaching and testing. The resulting critical reviews and expert opinions have helped to inform TOEFL program development efforts with respect to test construct, test user needs, and test delivery. Opinions expressed in these papers are those of the authors and do not necessarily reflect the views or intentions of the TOEFL program.

These monographs are also of general scholarly interest, and the TOEFL program is pleased to make them available to colleagues in the fields of language teaching and testing and international student admissions in higher education.

The TOEFL 2000 project is a broad effort under which language testing at ETS will evolve into the 21st century. As a first step in the evolution of TOEFL language testing, the TOEFL program recently revised the Test of Spoken English (TSE®) and announced plans to introduce a TOEFL computer-based test (TOEFL CBT) in 1998. The revised TSE test, introduced in July 1995, is based on an underlying construct of communicative language ability and represents a process approach to test validation. The TOEFL CBT will take advantage of the new forms of assessments and improved services made possible by computer-based testing while also moving the program toward its longer-range goals, which include

- the development of a conceptual framework that takes into account models of communicative competence
- a research agenda that informs and supports this emerging framework
- a better understanding of the kinds of information test users need and want from the TOEFL test
- a better understanding of the technological capabilities for delivery of TOEFL tests into the next century

It is expected that the TOEFL 2000 efforts will continue to produce a set of improved language tests that recognize the dynamic, evolutionary nature of assessment practices and that promote responsiveness to test user needs. As future papers and projects are completed, monographs will continue to be released to the public in this new TOEFL research publication series.

TOEFL Program Office
Educational Testing Service

Abstract

This report attempts to anticipate how changes in computer and communications technologies in North American colleges and universities by the year 2000 might change the way in which students do their work. Particular attention is given to changes in the importance of students' communication skills (e.g., listening, speaking, reading, writing).

The report describes the current environment in colleges and universities with respect to computer and communications technologies and examines factors that are necessitating change in that environment. Among these factors are significant changes in the student population (e.g., older, more diverse, more computer savvy, more who enroll on a part-time basis or commute). Other factors include tight institutional budgets, increasing competition, and increasing service expectations. These factors mean that institutions must be increasingly flexible in the times and locations in which they deliver educational services and must accomplish this at a low cost.

In response to these needs, colleges and universities will increasingly adopt computer and communications technologies. These technologies will allow them to move toward a "virtual campus," where interactions among students and with faculty are increasingly electronic, and specialized facilities, equipment, and other resources can be accessed remotely from students' homes or places of work at times that are convenient to them.

The report examines probable changes in students' academic environments by the year 2000, with special focus on computer-based tools (e.g., electronic mail, productivity software, on-line services), instruction, testing, and institutional administration. The likelihood that students will use or be exposed to certain technologies in their academic work in the year 2000 is estimated, with attention given to variation in usage based on the type of institution (community college, four-year general-purpose college, or research institution) and academic discipline.

While the changing academic environment will entail changes in the importance of specific communication skills, changes by the year 2000 will be relatively moderate.

This report provides recommendations to help the TOEFL program and ETS prepare for the year 2000 and beyond.

Acknowledgments

The authors gratefully acknowledge the support and suggestions of Carol Taylor, and Len Swanson, who both provided initial guidance. We also thank Isaac Bejar, Randy Bennett, Gary Buck, Susan Chyn, Charles Davis, Felicia DeVincenzi, Arthur Doyle, Doug Forer, Judith Mounty, Mary Schedl, Cecil Shaw, William Ward, and anonymous reviewers who provided insightful comments and suggestions.

Table of Contents

List of Tables

List of Appendices

I. Introduction

The Need

In attempting to plan TOEFL program services for the next decade, the TOEFL 2000 team wishes to better understand how changes in the college and university environment by the year 2000 might influence how students do their work and, hence, the kinds and levels of communication skills — listening, speaking, reading, and writing — that students will need for success. The TOEFL 2000 team asked the authors to develop a document that would help them anticipate these changes. This document is a response to that request.

The views expressed in this document are those of the authors and do not necessarily reflect the opinions of the TOEFL 2000 team, the TOEFL Policy Council, or Educational Testing Service (ETS). These views do not necessarily indicate the directions that will actually be taken in the development of new TOEFL or ETS products or services.

Purpose

The TOEFL 2000 team believes computer and communications technologies will play a potentially important role in changes that occur in the college and university environment and has asked the following questions:

1. How will computer and communications technologies be used in North American colleges and universities by the year 2000?

2. How might changes in the use of these technologies change the way students do their work?

The team has further expressed interest in how the answers to these questions might vary across disciplines and types of institutions.

Method

In answering these questions, we have attempted to (a) briefly describe the current use of computer and communications technologies in colleges and universities, (b) outline some key factors that are necessitating change in the university environment as a whole, (c) define a general direction in which change seems to be occurring with respect to computer and communications technologies, and (d) describe factors that are likely to influence the rate and shape of the change. We then give our best estimate regarding the condition that will exist in the year 2000, mostly in general, but with some attention to specific kinds of institutions and disciplines. We then offer some guesses as to how the conditions of the year 2000 will relate to the importance of students' English communication skills as a whole, as well as to the four major skills (listening, speaking, reading, and writing). Finally, we offer conclusions and recommendations.

In carrying out this work, we have consulted experts and the literature through a variety of means. We have used printed materials such as periodicals and journals, telephone and in-person interviews, and online resources such as newsletters and remote access information servers (e.g., World Wide Web and Gopher servers, newsgroups, and mailing lists).

In this research, we have attempted to draw the broad outlines of the changes that are expected, using selected current and anticipated technologies as instances of the types of technologies that we expect to play a role in the institutions of the year 2000. We have not attempted to anticipate every new technology that may exist in the year 2000.

The facts cited in this study pertain mostly to the United States, although we believe that most of the findings and conclusions will also pertain to Canada. Colleges and universities in the United States and Canada will benefit from the strong position that these countries hold in their access to computer technology, as well as in the improvement of their information infrastructures — the "information highway." The United States, Canada, Germany, and Japan are leaders in information technologies and are likely to be among the first to see their benefits. Progress will be slower in many of the less technologically advanced countries (Reinhardt, 1994).

II. The Current Situation

To have a frame of reference for the discussion of changes, we briefly consider how computer and communications technologies are used today at institutions of higher learning. This document is intended to address the situation of students at a wide range of institutions, including community colleges, four-year institutions, and universities.

We will consider these uses under four headings: tools, instruction, testing, and administrative information. The categories are not mutually exclusive. For example, "instructional assessments" — assessments with a significant instructional component — could come under both "Testing" and "Instruction." Depending on the specific product or how it is used, one of the two aspects could predominate; however, for consistency, instructional assessments are considered under "Testing."

Tools

Students currently have access to an increasing array of computer-related tools. Students are increasingly expected to know how to use personal computers and word processors or must learn to use these tools soon after matriculation. Other commonly used technologies include spreadsheet, presentation and database software, fax machines, and modems. Use of online information resources, including the Internet/Web and information services such as American Online, CompuServe, Prodigy, etc., is becoming increasingly common by students, faculty, and staff. Handheld calculators with significant computing and display capabilities are becoming an accepted tool for study, instruction, and testing in mathematics-intensive subjects.

Instruction

The uses of computer and communications technologies in instructional settings are diverse, but tend to be ancillary to the main instruction, in which lecture still dominates. As of about 1994, only about two to five percent of the lectures at even the most technologically advanced institutions incorporate data or presentation materials displayed via computer (Saltz & Oberst, personal communication, March 7, 1994), although computer-based work was and will continue to be often required outside of the lecture period. A small but increasing proportion of classes are based directly around computer-based or computer-assisted activities rather than lecture. Technologies in widespread use today in instructional settings are overhead projectors, slides, videotape recorders/players, (and to a lesser, but significant extent), television, personal computers, and conventional telephone. At the more technologically advanced campuses, professors regularly use networks and online databases to access a wider, richer information base for lectures and presentation. Students are beginning to access online library catalogs and other online resources for their own research. Specialized computer-based equipment is used for laboratory work in some courses.

Testing

Computer and related technologies are widely used in testing. The actual use of computer-based tests is still new or untried in many domains, however.

The most prevalent current uses of computer and communications technologies in testing in colleges and universities include regular productivity software (e.g., word processing, spreadsheet), graphics editors, and printing technologies for the design and preparation of paper-based or computer-based tests; mark sense readers for scanning and scoring "bubbled" answer sheets; computers, storage technologies, networks, and other technologies for registration, scheduling, reporting, and financial management functions of the testing process and for transforming, storing, and retrieving the data; and use of sophisticated handheld calculators during tests. With most of these more prevalent uses, the student has little direct interaction with the computer technology unless he or she also serves as an instructor, teaching assistant, computer lab assistant, or testing center staff member.

Computer-based tests are beginning to come into mainstream use for a variety of educational purposes, although the current impact on the day-to-day environment of the student is relatively low. Major educational purposes include placement, graduate school admissions, professional certification/licensure, and instructional assessment. During 1995, ETS administered more than 300,000 computer-based "high-stakes" tests (e.g., tests for graduate school admission, professional certification), including about 80,000 for the Graduate Record Examination's (GRE®) General Test. During the same period, it estimated that about 1 million additional Accuplacer Computerized Placement Tests (CPTs) were administered; scores on these course placement tests are generally not reported outside the institution. Total ETS test volume for that year was about 10 million, including Accuplacer (Kevin Gonzalez, ETS Communications Services, personal communication, February 14, 1996). On the whole, students' exposure to these computer-based tests from ETS or other organizations is relatively infrequent.

Computerized instructional assessments based around certain academic courses may be purchased commercially or created by instructors or others. For example, commercial computer-based instructional assessments (e.g., quizzes with feedback) or lab exercises may be included by textbook publishers or purchased separately as an option. Such assessments may include extensive instructional feedback (Meservy, personal communication, October 28, 1994). The Internet/Web appears to be poised for considerable growth for delivery of instructional assessments.

Administrative Information

At most institutions, computer and communications technologies have been used for many purposes for several years. For example, a common use is for the management of student registration, grade information, and other administrative purposes, none of which require special skills from most students. Another use of the technologies is touch-tone input by students for registration or other administrative purposes; many institutions, especially those with very large enrollments, have used this technology for several years.

Students are increasingly using computer and communications technologies to access administrative information and to interact with the institutional community. New uses include rapid electronic access to general information (e.g., course listings and requirements, calendars, maps, phone numbers) through computer (e.g., personal computer, kiosk), electronic communication for academic advising, and voice-

activated applications for administrative functions for student use. The overall level of use of these technologies by the "typical" student would currently be considered low, though with the rapid growth of the Internet/Web, this is changing rapidly.

The Meaning of "Levels of Use" by a "Typical Student"

In this document, we refer to levels of use of a certain technology by the "typical student." Who is the "typical student," and what is meant by the "level of use?"

When we refer to the "typical student" (without additional qualification), we are referring to a hypothetical "composite" student that represents the characteristics of all 14.5 million students in colleges and universities in the United States. About 40 percent of these students are at two-year institutions (i.e., community colleges), and about 47 percent are undergraduates at four-year institutions. Students in graduate and professional schools make up about 14 percent of all enrollments (Facts and Figures on U.S. Higher Education, 1994). These figures show that students in the lower years of the post-high continuum contribute much more "weight" to this composite student than do students in the higher years. (About half of all students at college and universities are in the first two years of undergraduate studies, and about 15 percent of that same population are first-year freshmen.) In this paper, the term "typical student" may sometimes be qualified to refer to a subset of the total student population (e.g., the typical student at a certain type of institution or within a certain academic discipline).

The "levels of use" refer to the probability that typical students use, or are exposed to, the technology during one year in connection with their academic work. The "Low," "Medium," and "High" ratings are general and, without more extensive research, cannot be tied to specific probability levels, although they are intended to cover the full range from 0 to 100 percent probability of use or exposure during the year.

III. Factors That Make the Change Necessary

Many important factors are necessitating changes in the colleges and universities in North America — changes that will impact the ways that computer and communications technologies will be used in these institutions and, perhaps, in the way in which students do their work.

Changes in the Student Population

One of the most important changes is the change in the student population.

- More "Older" Students. Students in higher education are, on average, older than before. By the year 2002, 43 percent of college students will be 25 and older, with 23 percent over 35 (Evangelauf, 1992). These students will still not constitute a majority of students in higher education by the turn of the century, but they will be a significant minority.

- More Part-Time and Commuting Students. Approximately 40 percent of all students attend a two-year college, and 43.5 percent attend college part-time ("Facts and Figures on U.S. Higher Education," August 25, 1993).

- More Diverse Student Population. The student population is increasingly diverse in background. A ten-year trend of strong growth in minority enrollments is expected to continue, with the highest percentage increases in Asian and Hispanic students (Shea, 1994). Furthermore, students with disabilities are expected to become a larger proportion of the student population due to implementation of the Americans with Disabilities Act (ADA) and related legislation, intended to ensure that reasonable accommodations are provided to people with disabilities. Societal awareness of disabilities, combined with legal protection, virtually ensures that a larger proportion of those with disabilities will be seeking education at institutions of higher learning.

- More Computer-Savvy Population. The typical student at a college or university of the year 2000 probably will be much more knowledgeable about computer and communications technologies and be more willing to use them in educational settings than the typical student of today. In the year 2000, students entering institutions of higher learning at a traditionally "young" age may still constitute a numerical majority, notwithstanding the increase in "older" students. These younger students will be members of a generation which will have had considerable experience with video games, probably some exposure to other interactive educational software, and perhaps some familiarity with the Internet/Web. The 18-year-old entering college in the year 2000 was born in about 1982 and is currently about age 15, an age that makes him or her likely to be a full participant in the current culture of video games and the Internet/Web. Even the "older," 25- to 35-year-old of the year 2000 was born in the period 1965 to 1975 and is currently about 22 to 32 years old, a range of ages in which exposure to video games, interactive software and Internet/Web browsers is quite likely. Thus, on average, students of the year 2000 are likely to more computer-savvy than students today.

In summary, the student population at institutions of higher learning in the year 2000 will include many older students, more with disabilities, more who are able to attend school only part-time because of job or family responsibilities, and more who have had previous experience with computer and communications technologies.

Other Factors

Other important factors that are expected to motivate change in colleges and universities include:

- Tight Budgets at Institutions of Higher Learning. Higher education is under pressure because of decreasing budgets and rises in operating costs. Most administrators surveyed in 1993 believed that enrollments at their institutions will grow by only 0 to 10 percent in the next five years, citing as primary factors the reduction of state or local government funding, as well as limits due to program capacity or other budgetary constraints (Facts and Figures on U.S. Higher Education, August 25, 1993).

- Increasing Competition. Many businesses, such as defense contractors, entertainment companies, and smaller entrepreneurs, are seeking to make inroads in the education and training market, including at the postsecondary level.

- Increasing Service Expectations. Across our society, customers — in this case, students — are increasingly demanding educational services that are perceived as immediately useful to them and are offered at convenient times and locations.

In summary, colleges and universities of the year 2000 will, on the whole, be working in a more competitive environment with an increasingly varied student population. This student population will have higher service expectations and increasing requirements for flexibility in the times and places in which they receive educational services.

IV. The Nature of the Change

Many institutions of higher education will see their best opportunity for strengthening their institutions as the accommodation of part-time students who are available for on-campus work only a few hours a week. While some colleges and universities may continue to select students who can give full-time attention to school, competition for new students and high operating costs oblige increasing numbers of institutions to provide greater flexibility, in time and location, to their students.

To remain viable, faced with these changes, institutions of higher education are looking for ways to deliver educational services (1) more flexibly and inexpensively, (2) to larger numbers of more diverse students, (3) with the same or reduced numbers of full-time faculty, and (4) with a greater focus on learning outcomes and fidelity to the demands of the workplace. Key concepts here are "flexibly" and "inexpensively." Increasing numbers of students will base their choice of institutions on accommodations provided for difficult schedules that include employment and family obligations. Students will increasingly demand rapid access — and as necessary, repeated access — to educational materials according to their own schedules.

Methods for Meeting the Challenge

Institutions will consider a wide range of options for increasing the flexibility of the delivery of educational services. Not all solutions to this problem will necessarily make heavy use of computer and communications technologies. For example, accommodations such as night courses, part-time enrollment, short courses, extension courses, and home study need not require much high technology. However, many institutions will begin to move toward partnerships with commercial organizations that want to deliver educational content electronically to homes and businesses. Others may develop extensive campus computer networks with remote-access facilities. Still others may partner with other institutions to offer long-distance delivery of specialized courses at several sites from a single institution.

Many agree that computer and communications technologies will play a critical role in meeting the challenge. As the prices of computer and communications technologies decrease and their capabilities increase, institutions will increasingly see the use of these technologies as a competitive advantage or necessity.

Colleges and Universities of the Future

There is wide agreement that, through the use of computer and communications technologies, students will increasingly be able to perform educationally-related tasks at a distance. They will be able to register, take courses, and interact with faculty, other students, and other educational resources from their homes or workplaces. For example, through electronic mail, the Internet/Web, interactive television, video mail, and desktop videoconferencing, students will be able to interact with others remotely and to access huge amounts of audio, video, and text information on demand.

Progression Toward a "Virtual Campus." There seems to be a high degree of consensus that colleges and universities will progress in their adoption of computer and communications technologies that, in the long term, will allow people to operate in a "virtual campus." Students, faculty, and staff will rely increasingly on computing and communications technologies for information and resources, while the role of face-to-face contact between people will decline in relative importance.

We offer the following sequence of stages as a somewhat simplified composite of changes that a variety of people are predicting:

Stage 1: The Virtual Library. The first stage (already well under way at some institutions), is a movement toward a virtual library, in which students and faculty access information electronically from libraries and other sources around the world, and the size of the collection of the institution one attends becomes a less reliable indicator of academic quality.

Stage 2: The Virtual Lecture Hall. The second stage is a movement toward the virtual lecture hall. In this stage, the emphasis is decreasingly on attending lectures in a single lecture hall. Lectures are available through interactive television or high-bandwidth, multimedia-capable networks for viewing at students' convenience. Interaction with the professor occurs outside of the class period, perhaps by electronic mail or desktop videoconferencing. Because they will not have to repeat similar lectures many times per week, faculty members will have more time to interact with students, answering their questions and discussing the project-oriented work that is expected to become increasingly dominant. The boundaries of the campus can be expanded significantly at this stage, if students use broadcast media to access lectures and "contact hours" are decreasingly the measure of teaching loads.

Stage 3: The Virtual Campus. The third stage is the virtual campus. At this stage, the college or university is almost not a "place" at all. Interactions among students and with faculty are electronic; specialized facilities, equipment, and other resources are accessed remotely. Two-way, real-time video communications become a commonplace part of the educational experience. The period of residence at a campus or other central facility becomes, on average, shorter, periodic, or both.

It is important to point out that progression between stages will be gradual rather than discrete, and particular departments or niches may move into a stage long before the institution as a whole. (Furthermore, as we point out later, some institutions may never move to Stage 3 or even to Stage 2.)

A Natural Progression. The foregoing progression is a natural continuation of the process begun decades ago. The three stages represent progressively greater degrees of access and dissemination of knowledge and information, but this process has been occurring for many decades in higher education. For much of our nation's history, institutions of higher learning — primarily universities — were few and relatively inaccessible to the average person. Then colleges — some of them land-grant colleges — brought many of these educational resources to more remote regions. Four-year colleges were followed by rapid growth in two-year community colleges that have served an increasingly large and varied

student population. Now, through technological advances, many of these institutions, as well as other educational service providers, will use technology to make resources available to an increasingly varied student population at home and in the workplace.

Changes in Roles of Faculty and Students

Potential changes in the roles of faculty and students are more controversial, but are a serious consideration. One vision of the future posits that the movement toward the virtual campus will alter the traditional roles of faculty and students. Over time, these changes will be characterized by an increased emphasis on accessing information by computer, that could result in a much more interactive learning experience.

- Faculty. Faculty will eventually become coaches, playing a larger role in motivating students to learn about their subject and a smaller role in explaining it. They will spend more time authoring technology-based materials that are available at all times to students. Some will build their academic reputation on the basis of their creativity and ability to author learning materials. They will also play a greater role in helping students to navigate — to establish learning goals and to select from a worldwide library of multimedia materials (Jensen, 1993).

- Students. Students will increasingly take more responsibility for, and a much more active role in, their learning. They will create their own materials from resources available around the world, working in groups to create new understanding and new products. This will more closely parallel the ways they will work after they graduate (Foa, 1993).

While this vision of role change seems reasonable and probably desirable, its fulfillment is less than certain. The traditional roles might be more persistent than has been supposed. It seems likely that students of the year 2000 will see themselves as users of electronic information technologies; they will be a generation raised on video games, personal computers, and electronic calculators. However, it is not as clear whether students will take on a significantly greater responsibility for their own learning (i.e., become knowledge constructors). A combination of social, emotional, intellectual, technological, and other factors might prevent such a role change from occurring on a widespread basis or enduring for a significant length of time. Thus, the extent to which these technologies will lead to a significant or long-lasting shift in roles is less certain than the increasing use of the technologies.

The Rate of Change

Where are colleges and universities now in relation to these stages, and how fast will they progress through them? Stage 1 (Virtual Library) is already under way at many institutions. Stage 2 (Virtual Lecture Hall) is currently becoming a reality with a few early adopters and will probably be much more common in the next five or ten years. A few early adopters are implementing elements of Stage 3

(Virtual Campus), but this vision may take decades to become widespread and may never become a dominant mode of educational delivery.

Some believe that Stage 3 (Virtual Campus) will never be reached, particularly at some of the more selective institutions (Gilbert, personal communication, March 23, 1994). Some of the most distinguishing features of the most selective institutions might well be their requirements for full-time (rather than part-time) enrollment, campus (rather than off-campus) housing, and provision of instruction through face-to-face human interaction (as opposed to electronically mediated interaction). In the long run, only the more well-funded or selective institutions may be able to give students the "luxury" of low-tech human interaction with teachers and other students.

In general, the prediction is for incremental, rather than revolutionary, change in the educational environment, with each new advance being tried by a few early adopters who possess an adequate mix of vision, need, wealth, commitment, and/or enthusiasm. Early adopters tend to experience a high rate of failure as the bugs are worked out of the technology. They also tend to pay high prices for the innovative equipment. Many early adopters are willing to work on the cutting edge (some say "bleeding" edge), however, because of the competitive or other advantage that comes from being the first to be successful in some domain. As many of the bugs are worked out, "second adopters" begin to buy in and help bring down the price of the technology. With the price down and with greater public knowledge, a more general population will then accept the maturing technology. This adoption process does not happen overnight. Risk of failure may be increased by attempting to make a transition too rapidly, as well as too slowly (LeGates, 1994).

Why will the adoption of computer and communications technologies occur somewhat slowly? During an interview, one expert said, — perhaps somewhat in jest, — "Higher education is designed to be impervious to change" (Gilbert, personal communication, March 7, 1994). This view is not universal, and there are growing signs of change; however, many observers have been dismayed and disappointed at the slowness of the change. Many factors moderate or slow the movement of institutions through these stages. Significant factors include the reward structure that keeps faculty members from involving themselves in nontraditional approaches to educational materials; the limitations of technology, including lack of bandwidth and standards to support rapid, widespread introduction of technologies such as interactive television and desktop videoconferencing; and the costs of retrofitting many campus buildings with the wiring and equipment necessary to support increased use of computing and communications technologies. Other significant factors are the shortage of available, high-quality educational software and lack of resources on many campuses to support faculty use of applications that do exist; the costs of developing many of the new educational materials, which will be beyond the capabilities of most individuals and require support from a team for successful production; and some natural (and perhaps reasonable) concern that moving too rapidly away from ordinary face-to-face campus interaction may damage the sense of community at the institution (Albright & Graf, 1992; Jensen, 1993; Fawson & VanUitert, 1990).

V. Predictions for the Year 2000

Having outlined the general direction of change, we now consider some specific predictions for the year 2000.

Technologies Students Will Use in the Year 2000

By the year 2000, noticeable changes will occur in the technologies in widespread use on campus.

Tools. At all types of colleges, the following technologies and applications will become routine tools, with widespread use at even the most technologically conservative campuses:

- Word processing
- Electronic mail, newsgroups, and bulletin boards
- Networked computers, in campuswide local area networks (LANs), and national and international networks (e.g., World Wide Web)
- Online information services and publications
- Student and faculty access to computers
- More advanced printers (e.g., color), copiers, and fax machines

One distinguishing factor of the above list is that it consists solely of "worldware" — technologies and software developed for purposes other than instruction, such as for personal productivity (Ehrmann, March 13, 1994).

The following technologies will be much more common on campuses than they are today:

- Voice messaging
- Voice-operated interfaces
- Multimedia-capable computers and networks
- Computer-based or computer-assisted instruction
- Distance learning, from one site to many
- Video and network technologies for time shifting, temporal flexibility, geographic flexibility
- Groupware for teams to view/work on documents and projects
- Computer-based technologies to assist students with disabilities

While the foregoing technologies will be much more common, they are unlikely to dominate instructional delivery except in specialized or rare settings in the year 2000.

Instruction. Use of technologies for instruction will grow considerably by the year 2000; as at present, this will primarily be in the area of ancillary materials. Use of online library resources as ancillary educational materials will increase dramatically. Instructional use of computer-based materials during lectures will increase, but will still be used in a minority of classes. Our most optimistic experts predict that, by the year 2000, 30 to 40 percent of the lectures may involve display or discussion of

computer-based data or presentation materials (Schneiderman, 1994). This is a considerable increase from the perhaps two to five percent of lectures in which even the most technologically advanced institutions now incorporate data or presentation materials displayed by computer in 1994 (Saltz & Oberst, personal communication, March 7, 1994). Simulations and computer-based lab exercises covering specialized topics within a course will play an increasing role.

In the year 2000, a small but growing proportion of courses will deliver the core educational experiences through computer-based approaches instead of ordinary lecture. These will include science and engineering courses, many of which already rely heavily on computers (e.g., computer science, computer-aided design, computer-aided manufacturing), as well as other courses. Courses in a variety of subjects will be oriented around computer-based lab exercises, tools, and simulations. For example, real-time conferencing over networks can become a core educational experience in writing and other humanities subjects (Bertram, 1993).

Courses using computer-based approaches to deliver the core educational experiences will be in the minority in the year 2000, in spite of significant increases in the use of the technologies. For example, there will probably continue to be relatively few courses in which computer-assisted instruction (including computer-based tutorials) provide most of the course content. One expert cites a network-based writing approach which, while having many advantages over traditional approaches demonstrated over a period of 10 years, has actually been tried by only five percent of those individuals who were apparently in a position to do so (Gilbert, personal communication, October 12, 1994). We cannot assume, therefore, that the availability of apparently adequate technological or other resources will guarantee the rapid adoption of an educational innovation.

On the whole, instructional uses of computer and communications technologies will continue to serve an ancillary or supplementary role. A small but increasing proportion of courses, however, will use computer and communications technologies to deliver the core educational experiences.

Testing. Most current uses of computer and communications technologies in testing (e.g., computer-based scoring, analysis, and reporting of paper-based tests) are expected to be common in the year 2000. In addition, they will be augmented by greater prominence of computer-based testing.

Computer-based testing will become more common for all major educational purposes (e.g., placement, graduate school admissions, college admissions, professional licensure/certification, instructional assessment). For example, ETS, which in 1995 conducted the largest volume of computer-based educational tests worldwide, plans to test 1 million students by computer during one year beginning in late 1997, compared with about 300,000 in 1994 (Reuter America Inc., 1994).

In spite of the probability of considerable growth in computer-based testing, the impact of that growth on the nature of the students' academic experience is expected to be small. In general, computer-based testing will make assessments easier for educators to administer and more convenient for students to receive. Changes in the communication skills required for student success in the year 2000 are

expected to be small. A few specific areas for growth in computer-based testing, some of which likely have an increasing influence on the academic environment, are discussed in Appendix A.

Administrative Information. We expect considerable growth in the use of computer and communications technologies for administrative information purposes. Continuing financial pressure will motivate many institutions to seek ways to lower costs through the use of these technologies. Electronic transfer of transcripts is expected to become more common. The availability of kiosks and public-access, web-capable computers for obtaining course and registration information is expected to increase dramatically, especially in larger public four-year institutions. Improved telecommunication (e.g., Integrated Services Digital Network [ISDN] and higher bandwidth service) and interactive television (ITV) to students' homes and workplaces for administrative (as well as instructional) uses may be most significant in community college settings.

Important areas for future growth are the labor-intensive areas of academic advisement and articulation. Automated degree audit systems, which help determine student progress toward fulfillment of degree requirements, will make academic advisement easier for both students and advisers. Articulation systems will become increasingly sophisticated in their ability to determine to what extent credits will transfer between one institution and another and can include degree audit capabilities. Institutions that can provide almost instantaneous feedback to students regarding what credits can transfer and what additional requirements must be fulfilled to graduate are likely to have a competitive advantage in attracting students. Research institutions generally will lead in the experimental use of advanced technologies for advisement and articulation.

We do not expect that students will have to significantly increase their skill because of these changes. Overall, students' interaction with the institution through administrative information systems may become somewhat easier.

Variation by Type of Institution

The expectation for the year 2000 is that the technologies in use and the rate at which they are adopted will vary by type of institution. In Table 1, we have defined three categories of institutions and estimated the level of use of computer and communications technologies in each. These categories are as follows[1]:

1. Community Colleges are distinguished by large, part-time, commuter enrollments, as well as, more teaching-oriented missions than the other types of institutions.

[1]These are our own categories and are not intended to cover all types of colleges or to correspond to any higher-education taxonomies, such as Carnegie classifications (Carnegie Foundation for the Advancement of Teaching, 1987).

2. Four-Year Multipurpose Colleges are regular four-year colleges that are not striving for leadership in the uses of high technology in education. A large portion of four-year colleges fall into this category.

3. Research Institutions are institutions that concentrate on enhancing education with computer and related technologies. They often are universities, but may include some four-year colleges. Some of these institutions may forge alliances and cooperative arrangements with high-tech corporations and develop new tools and approaches (i.e., Project Athena funded by Digital Equipment Corporation [DEC] and IBM at MIT, or the Andrew Project funded by IBM at Carnegie Mellon University).

Table 1 provides a general estimate of the probability that a typical student (undergraduate or graduate) in each institution type will use, or be exposed to, the various computer and communications technologies in the year 2000 in connection with academic work[2]. Technologies are divided into four major categories: (1) tools, (2) instruction, (3) testing, and (4) administrative information technologies[3]. A "High" rating does not necessarily mean that the particular technology will dominate in its realm. Other, perhaps "low-tech," technologies may still be dominant. In addition, a technology with a "Low" overall rating may have a "Medium" or "High" rating if the focus is on certain subgroups. For example, a computer-based placement test may be used by only a very small proportion of the total student population (as suggested in the "Low" rating in the table), but would be used by a higher proportion of the subset who are beginning their first year at a school.

[2] The table is intended to indicate levels of use for the typical student for the year 2000, instead of for any subset of the student population. Furthermore, the table does not indicate rates of growth in use of the technologies.

[3] As noted earlier, the "Low," "Medium," and "High" ratings are general and, without more extensive research, cannot be tied to specific probability levels.

Table 1 Probability of Student Use of Technology at Three Kinds of Institutions in the Year 2000

Technology		Community College	Four-Year Multi-Purpose College	Research Institution
Tools				
1.	Electronic access to library catalog	High	High	High
2.	Text-based electronic mail and bulletin boards	High	High	High
3.	Voice messaging for faculty and staff	High	High	High
4.	Voice messaging for students	Moderate	High	High
5.	Personal computer	High	High	High
6.	Productivity software (word processors, grammar and style checkers, spreadsheets, personal databases)	High	High	High
7.	Presentation software	Moderate/High	Moderate/High	High
8.	World Wide Web and other international networks for pursuit of personal interests (newsgroups, mailing lists)	Moderate	Moderate	Moderate/High
9.	World Wide Web and other international networks for academic research	Low/Moderate	Moderate	Moderate/High
10.	Personal digital assistants (PDAs)	Low	Low	Low
11.	Two-way, real-time, on-demand videoconferencing between student and instructor or other students	Low	Low	Low
Instruction				
12.	Motion video by videotape in the classroom	High	High	High

	Technology	Community College	Four-Year Multi-Purpose College	Research Institution
13.	Specialized, discipline-specific, computer-delivered materials (lab exercises, simulations) that are ancillary parts of the course	Moderate	Low/Moderate	Moderate/High
14.	Scheduled motion video by satellite or cable, used by instructor in the classroom	Moderate	Low/Moderate	Low/Moderate
15.	Computer-delivered multimedia, used by instructor in the classroom	Moderate	Moderate	Moderate
16.	Computer-assisted instruction that covers most of the content of a course	Low	Low	Low
17.	A course requiring very little (if any) on-campus attendance and making significant use of electronic communication (e.g., electronic mail, web pages)	Low/Moderate	Low	Low
18.	A course requiring very little (if any) on-campus attendance and making significant use of real-time video with narrow-band (e.g., ordinary phone line) voice or data feedback to instructor	Low	Low	Low
19.	A course requiring very little (if any) on-campus attendance and making significant use of two-way, real-time, motion video	Low	Low	Low
20.	A course for which computer and communications technologies play a critical role in making the content accessible to people with disabilities	High	High	High

	Technology	Community College	Four-Year Multi-Purpose College	Research Institution
21.	A course for which the essential elements of the content are available through technology in additional parallel versions (e.g., captions, video description, Braille, sign language video versions) for individuals who are deaf or hard of hearing, have specific learning disabilities, or are blind or have visual impairments (Note: Levels of usage will vary widely by locale.)	Low	Low	Low
22.	A course for which most textual materials are available in a written/spoken language other than English (e.g., student chooses presentation language, such as Spanish) (Note: Levels of usage will vary widely by locale.)	Low	Low	Low
Testing				
23.	A paper-based test that uses a scannable mark sense (e.g., bubble) sheet and produces computer-readable output	Medium/High	Medium/High	Medium/High
24.	A computer-based test in any academically related setting (e.g., placement, graduate school admissions, professional certification/licensing, instructional assessment, college admissions)	Low/Medium	Low/Medium	Low/Medium
25.	A computer-based test that uses sophisticated algorithms for scoring constructed responses (e.g., non-multiple-choice responses) or for adapting to the individual test taker (e.g., adaptive testing)	Low	Low	Low

	Technology	Community College	Four-Year Multi-Purpose College	Research Institution
26.	A computer-based test in which the essential elements of the content are available through technology in additional parallel versions (e.g., captions, video description, Braille, sign language video versions) for individuals who are deaf or hard of hearing, have specific learning disabilities, or are blind or have visual impairments (Note: Levels of usage will vary widely by locale.)	Low	Low	Low
Administrative Information				
27.	Rapid electronic access to general information (e.g., course listings and requirements, calendars, maps, phone numbers) through computer (e.g., personal computer, kiosk)	Moderate/High	Moderate/High	Moderate/High
28.	Touch-tone input by students for registration or other administrative purposes	Moderate	High	Moderate
29.	Student use of electronic communication for student registration and other private administrative purposes	Low/Moderate	Low/Moderate	Moderate
30.	Electronic communication for academic advising	Moderate	Moderate	Moderate
31.	Voice-activated applications for administrative functions for student use	Low/Moderate	Low/Moderate	Low/Moderate
32.	Advanced systems for automated academic advisement	Low	Low/Moderate	Low/Moderate

The community colleges will be among the most progressive in using computer and communications technologies in operational (i.e., ongoing) teaching and learning settings, including delivery of instruction to student homes, workplaces, and other remote sites (Doucette, 1990; Green, 1994; Johnson, personal

communication, November 18, 1994; Anandam, personal communication, January 4, 1995). Community colleges are already among the most progressive institutions in the use of cable television, satellite, and other forms of distance learning. While many of these institutions currently lack the most advanced computer and communications technologies infrastructure, this is changing rapidly. Community colleges will be playing a major role in meeting the educational needs of part-time, older students who frequently have job and family responsibilities.

The four-year multipurpose colleges will be moderately progressive with respect to technology but, due to budgetary and other constraints, will tend to use commercial tools or obtain them from research institutions. Many four-year multipurpose colleges are likely to lag behind many of the more progressive community colleges in using these technologies, although the larger ones probably will be among the most progressive in using academic advisement and articulation systems.

The research institutions will make the most aggressive use of computer and communications technologies, but often more in small-scale research settings than for operational, instructional, or administrative uses. Research institutions will lead the way in experimenting with new technologies. Other institutions, however, especially the community colleges, may be more progressive in their implementation of technologies that are ready for practical, widespread use in teaching and learning (Anandam, personal communication, January 4, 1995).

As mentioned earlier, with a continuing increase in the use of communications technology, the current dominance of face-to-face live contact with instructors within a classroom or lecture hall will be reduced. Eventually, the dominance of face-to-face live contact between instructors and students may become a distinguishing feature of more selective institutions, although we do not expect this to be strongly evident by the year 2000.

Variation by Discipline

The use of computer and communications technologies will vary by academic discipline. This variation will be most apparent in the use of discipline-specific software applications, such as domain-specific simulation and modeling applications. In addition, certain general tools or technologies may have very different levels of importance in different disciplines. For example, full-text search technology may have special importance in the humanities (for searching and analyzing online literary works), whereas presentation software may have special importance in the graphic arts (for visualizing designs).

Although the specific technologies used will vary by academic discipline, Albright and Graf (1992) suggest the following general purposes for which faculty will use these types of materials:

- To accomplish tasks they cannot do themselves (e.g., simulations of dangerous or expensive experiments)
- To accomplish tasks better than they can themselves (e.g., visualization of microscopic worlds)

- To perform routine teaching tasks that they prefer not to do (e.g., drill and practice exercises)
- To prepare students for the world of work (e.g., become familiar with the tools they will use on the job)
- To enhance faculty and student productivity (e.g., through use of electronic mail, word processor, spreadsheet, database, text retrieval)

Table 2 shows representative technologies that are expected to find growing use in particular disciplines.

Table 2 Representative Technologies in the Year 2000 by Discipline

Discipline	Representative Technologies
Accounting	Case and data search, case-based reasoning in auditing and other specialties
Architecture	Computer-aided design, simulations
Business	Commercial applications used widely in industry, simulations, video broadcast of courses, groupware for team projects
Computer Science and Engineering	Simulations, modeling
Education	Video technologies for instruction and performance assessment, use of Internet/Web for classroom application
Foreign Languages	Simulations, multimedia applications incorporating language and culture, drill and practice
Graphic Arts	Access to and ability to manipulate images of works of art, computer-aided design
Humanities	Access to full text of literary and historical works, multimedia compilations of interdisciplinary materials
Law	Online databases for case search, video broadcast of courses
Library Science	Internet/Web and other online resources for research, cataloging
Medicine	Simulations, videoconferencing for remote or group diagnosis
Natural Sciences	Modeling, simulations of environments and phenomena that cannot be naturally produced or easily observed
Social Sciences	Video technologies for interview research, statistical utilities

As suggested earlier, even though the foregoing may be instructionally significant uses of technology, they are not generally expected to dominate more traditional instructional methods.

Changes in the Importance of Skills

Overall Importance of Skills. The importance of key communication skills — listening, speaking, reading, and writing — is expected to be maintained, if not enhanced, through the year 2000. Students must be able to receive information, process it, and communicate that processed information to others. Greater recognition of the importance of collaborative or cooperative learning, as well as the importance of workplace skills (which tend to rely on social interaction), may increase the overall importance of these skills. Communication skills are essential in both group learning and workplace settings.

Relative Importance of Skills. The relative importance of the four major communication skills is expected to remain stable between now and the year 2000, perhaps with some minor exceptions.

The relative importance of listening skills may decrease slightly due to a combination of the ability to replay multimedia or digitized voice materials, the emphasis on collaborative instead of lecture-based learning, and the increased emphasis on electronic mail and other electronic means instead of face-to-face communication.

The relative importance of reading skills is expected to remain constant through the year 2000, because the increased importance of reading electronic mail and other textual information will balance any replacement of printed materials with multimedia information.

The relative importance of speaking skills is also expected to remain stable, due to the conflicting effects of technology. The emphasis on collaborative learning will increase the need for speaking skills, while widespread use of text-based electronic mail will decrease it.

The relative importance of writing skills may increase slightly due to widespread electronic means for distributing or "publishing" one's writing, although much of this written communication (e.g., electronic mail, online chat, web home pages) tends to be informal and, thus, may not require higher levels of writing skill. The widespread availability of spelling, style, and grammar checkers may affect the types of writing skills that are most important for students to possess.

Interchangeability of Skills. By the year 2000, there may a slight increase in the interchangeability of communication skills. The growing importance and availability of multiple modalities of communication (e.g., text, pictures, motion, and audio) will increasingly provide students with redundant information. (Some of the increasing availability of multiple modalities will result from accommodations made for people with disabilities in one or more communication skill areas; for example, the audio portion of a presentation might be accompanied by both a captioned English text version and a video version showing a translation in American Sign Language.) This redundancy may result in an increase in the extent to which

one skill — listening, speaking, reading, or writing — might be replaced by another. Thus, in the year 2000, a partial deficit in one skill will perhaps be more amenable to compensation by another skill than it is today.

Additional Skills. This paper has focused on the English communication skills of listening, speaking, reading, and writing. Other skills, however, might take on greater importance in the communication environment of colleges and universities of the year 2000. For example, certain visual-related skills might become important with the increasing use of graphics, animation, motion video, and virtual environments. Furthermore, with the increasing diversity of information media, the skill of switching and sharing between various communication modalities may become increasingly important. For example, one may wish to assess the students' skill in coordinating and switching between different communication modes (i.e., listening, speaking, reading, and writing) and between different representational systems (e.g., words, graphs, tables, numbers, computer languages, still/motion pictures, musical notation, dynamic models). The importance of visual-related or other additional skills is expected to increase gradually in its relation to the skills of listening, speaking, reading, and writing, although the extent to which measures of such skills would be warranted in the assessment of English communication skills is not clear.

VI. Conclusions and Recommendations

Conclusions

In general, the rate of change or movement from virtual library to the virtual lecture hall to the virtual campus is predicted to be fairly slow and evolutionary rather than revolutionary. By the year 2000, changes at most institutions are expected to be noticeable, but not dramatic. Here, we summarize the conclusions of this study:

1. Factors That Make Change Necessary. What are the key factors making change necessary in the environment of colleges and universities as a whole?

   Among the more important factors are: (a) an older, more varied student population (more part-time, more commuters, more minorities, more students with disabilities); (b) greater computer savvy among students; (c) tighter institutional budgets; (d) more competition from other institutions; and (e) increasing service expectations in society.

2. General Direction of Change. What is the general direction in which change seems to be occurring with respect to computer and communications technologies?

   The general trend in colleges and universities is toward greater use of computer and communications technologies for both instructional and ancillary functions. The adoption of these technologies enables a progression from a virtual library to a virtual lecture hall and, finally, to a virtual campus, in which students may access the major knowledge and information resources of the institution electronically from their homes or workplaces.

3. Factors Moderating the Rate of Change. What factors are likely to moderate or influence the rate of change?

   Many factors will moderate the speed with which the changes occur. Among the more significant factors are: (a) the reward structure that keeps faculty from involving themselves in nontraditional approaches to educational materials; (b) current and expected limitations of technology; (c) costs of retrofitting campus with wiring and equipment; (d) shortage of high-quality educational software and lack of resources on many campuses to support faculty use; (e) costs of developing new educational materials; and (f) concern for loss of a sense of community if movement away from face-to-face campus interaction comes too quickly.

4. Use in the Year 2000. How will computer and communications technologies be used in colleges and universities in North America by the year 2000?

   Computer and communications technologies will be used extensively in the major areas of tools, instruction, testing, and administrative information.

Tools such as word processing, electronic mail, internet browsers, and online databases are expected to become prevalent, along with higher-bandwidth networks and more capable printers, copiers, and fax machines.

Instructional uses of computer and communications technologies will increase, although most instruction in most settings will continue to be face-to-face in classrooms and lecture halls, rather than at a distance electronically. Through the widespread use of electronic mail and internet browsers, and the increasing availability of video mail, interactive television, and desktop videoconferencing, students will increasingly be able access information and obtain instructional services with greater flexibility of time and location. At many institutions, students will be able to access huge amounts of audio, video, and text information on demand, creating a "virtual library." Instructional use of computer-based applications such as simulations, modeling, expert systems, and computer-assisted instruction also will increase, but will usually continue to serve an ancillary function instead of becoming a primary mode of instructional delivery (except in specialized settings).

Testing will be increasingly computerized, although noncomputer-based delivery (e.g., ordinary paper-based testing, including the use of mark sense readers) will also continue to thrive. Computer-based testing will provide increasing flexibility regarding the timing and location of testing. Use of multimedia in testing will increase considerably in instructionally oriented assessments. The introduction of specialized testing approaches (e.g., computer-adaptive testing, automated scoring of constructed responses) will increase but will continue to be a small portion of computer-based testing.

Use of the technologies for administrative information purposes will increase. Electronic transfer of transcripts is expected to become more common. The availability of kiosks and public-access computers for obtaining course and registration information is expected to increase dramatically, especially in larger, public, four-year institutions. In automated academic advisement and articulation, applications will be small but increasingly important.

5. Influence on Student Work. How might changes in the use of computer and communications technologies change how students do their work?

How students do their work in the year 2000 will be somewhat different from the way they work today, but this change will be moderate for the typical student. Access to information will be easier, and there will be greater flexibility in the times and locations at which educational services (including instruction, tests, and administrative services) are received. This flexibility might offer students more time to focus on other curricular or extracurricular interests, needs, or responsibilities.

Use of computer and communications technologies in instruction, the area that may have the greatest potential impact on the student's academic experience, will become much more common, but will probably not become the dominant mode of instructional service delivery by the year 2000. Institutions will increasingly explore the use of technology in instructional delivery, but progress probably will differ widely from campus to campus, as well as from discipline to discipline and from professor to professor. Traditionally, the professor has control over the content and delivery of courses, and this is not expected to change greatly by the year 2000. By that time, as many as 30 to 40 percent of the lectures may involve display or discussion of computer-based data or presentation materials (Schneiderman, 1994). While the use of computer and communications technologies in instruction is expected to increase considerably, it is unlikely that any single instructional application (i.e., a "killer" application) will transform instructional delivery by the year 2000.

6. Importance of Students' Communication Skills. How would changes in the way students work in the year 2000 influence the importance of the key communication skills (i.e., listening, speaking, reading, and writing skills) required for success in higher education?

   A. Overall Importance of Communication Skills. Compared with their importance today, we expect that by the year 2000, the overall importance of key communication skills — listening, speaking, reading, and writing — will be maintained, if not enhanced. Students must be able to receive information, process it, and communicate that processed information to others. Furthermore, the increasing recognition of the importance of collaborative or cooperative learning, as well as the importance of workplace skills (which tend to rely on social interaction) may further increase the overall importance of the communication skills.

   B. Relative Importance of Individual Skills. The relative importance of each of the four major communication skills — listening, speaking, reading, and writing — is likely to be maintained, with perhaps a slight increase in the importance of writing (largely due to the prevalence of electronic mail) and a slight decrease in the importance of listening (because of the capacity to play back recorded audiovisual materials).

   C. Interchangeability of Individual Skills. Due primarily to the redundancy of modalities of presentation (e.g., audio, video, as well as text), there may be a small increase in the extent to which competency in one communication skill might compensate for a deficit in another skill.

   D. Additional Skills. Additional skills not included under the heading of the four main English communication skills (listening, speaking, reading, and writing) may take on greater importance. For example, certain visual-related skills might become important with the increasing use of animation, motion video, and

virtual environments. In addition, the increasing diversity of information media may increase the importance of the ability to coordinate and switch between different communication modalities and between different representational systems.

In general, the putatively moderate changes in how students do their work will result in small changes in the importance of these skills. All the skills — listening, speaking, writing, and reading — will still be important. There may be slight changes in the importance of certain skills. Some additional skills may become more important, although this may not be evident by the year 2000.

This study has focused primarily on changes related to the use of computer and communications technologies. Other social, technological, economic, or other factors also could influence the importance of communication skills.

General Recommendations

Following are general recommendations for preparing to develop products and services that meet the needs of students who will be attending colleges and universities in the year 2000 and beyond:

1. Plan for Long-Term Change.

The TOEFL program should actively prepare for long-term change in both the academic environment of institutions of higher learning and in the environments in which the TOEFL program and ETS operate. The TOEFL program and ETS will face a highly competitive environment in the future, as will institutions of higher learning. To be successful in the future, TOEFL needs to plan now for changes that may be evident only in small measure by the year 2000. A main message of this document is that the change in the university environment between now and the year 2000 will be relatively small or moderate and will proceed in an evolutionary, instead of revolutionary, way. Yet we also wish to emphasize that important changes are coming, and we believe that TOEFL and ETS need a long-term plan to thrive. Thus, we recommend looking seriously at both the short- and long-term implications of widespread adoption of computer and communications technologies and planning for them. Furthermore, during the planning process, the TOEFL program and ETS need to be alert to the wide range of events and factors — social, technological, economic, or other — that could affect the environment in which they and their clients will operate in the year 2000 and beyond.

2. Prepare to Increase the Variety of Ways of Demonstrating Communicative Competence.

To maintain fidelity to the communication demands of the educational and work environments of the future, TOEFL and other ETS programs should actively plan and investigate different ways for test takers to demonstrate their communication skills.

virtual environments. In addition, the increasing diversity of information media may increase the importance of the ability to coordinate and switch between different communication modalities and between different representational systems.

In general, the putatively moderate changes in how students do their work will result in small changes in the importance of these skills. All the skills — listening, speaking, writing, and reading — will still be important. There may be slight changes in the importance of certain skills. Some additional skills may become more important, although this may not be evident by the year 2000.

This study has focused primarily on changes related to the use of computer and communications technologies. Other social, technological, economic, or other factors also could influence the importance of communication skills.

General Recommendations

Following are general recommendations for preparing to develop products and services that meet the needs of students who will be attending colleges and universities in the year 2000 and beyond:

1. Plan for Long-Term Change.

The TOEFL program should actively prepare for long-term change in both the academic environment of institutions of higher learning and in the environments in which the TOEFL program and ETS operate. The TOEFL program and ETS will face a highly competitive environment in the future, as will institutions of higher learning. To be successful in the future, TOEFL needs to plan now for changes that may be evident only in small measure by the year 2000. A main message of this document is that the change in the university environment between now and the year 2000 will be relatively small or moderate and will proceed in an evolutionary, instead of revolutionary, way. Yet we also wish to emphasize that important changes are coming, and we believe that TOEFL and ETS need a long-term plan to thrive. Thus, we recommend looking seriously at both the short- and long-term implications of widespread adoption of computer and communications technologies and planning for them. Furthermore, during the planning process, the TOEFL program and ETS need to be alert to the wide range of events and factors — social, technological, economic, or other — that could affect the environment in which they and their clients will operate in the year 2000 and beyond.

2. Prepare to Increase the Variety of Ways of Demonstrating Communicative Competence.

To maintain fidelity to the communication demands of the educational and work environments of the future, TOEFL and other ETS programs should actively plan and investigate different ways for test takers to demonstrate their communication skills.

We see four major forces that are likely to increase the demand for products and services and to allow different ways for the candidate to demonstrate communicative competence:

A. Multiple Information Sources and Access Modalities. Students and workers of the future will use more information sources (e.g., current sources plus online information sources, interactive cable television) and will access this information through multiple modalities (e.g., pictures, motion, audio, and text). In doing so, learners will have increased opportunity to use a strength in one communication skill to compensate for a weakness in another skill (for example, strength in listening comprehension to compensate for a weakness in reading comprehension, or vice versa).

B. Educational Focus on Group Work. We anticipate continued emphasis on group work, collaborative learning, cooperative learning, and team projects in both educational and work environments. Group work tends to place a high demand on communication skills as a whole; more to the point, group work places a premium on complementing one's own strengths with those of others, with each member of the group exercising a different set of skills during successful execution of the group task. Much group work offers some choice as to how to allocate responsibilities among individuals. This makes it possible for each member of a group to demonstrate competence by making an essential contribution to the success of the whole, but the particular set of skills — including communication skills — exercised by each individual may differ. Thus, group work tends to allow different ways of demonstrating communication and other competencies. (The increase in the importance of group work, however, is likely to differ significantly by work setting and by academic discipline and level of study.)

C. Accommodations for Persons with Disabilities. The expected increase in the number of people with disabilities in higher education and the workplace will increase the need to provide different ways of demonstrating communicative competence.

Some differences in ways of demonstrating communication skills occur in existing accommodations in educational and professional assessment. For example, a test designed to assess "verbal reasoning skills" may ordinarily require the test taker to read the questions; an accommodation for a person who is blind may instead allow that person to listen to the questions. Thus, both the listening and reading versions of the test may be deemed, through empirical or other considerations, to assess the same construct — verbal reasoning[4].

[4]At least in the near term, accommodations that allow an alternate communication modality are probably less feasible in job-related assessments than in assessments of certain cognitive abilities (e.g., verbal reasoning) (Bennett, personal communication, September 25, 1995). Job-related skills are often tied to specific communication modalities (e.g., comprehension of a paper-based repair manual or execution of verbal instructions

While the issues involved in providing accommodations are complex, ETS and its programs should adhere to both the spirit and letter of the Americans with Disabilities Act of 1990 (ADA) and earlier federal legislation (e.g., the Rehabilitation Act of 1973)[5]. ETS and the programs can do this by giving test takers with disabilities every opportunity to convey what they know in the manners and modalities that allow them to best demonstrate their communicative competence.

People with disabilities should be kept in mind from the beginning when designing new products and services, thereby reducing the challenges encountered when trying to retrofit these products and services after they have been created. Appendix B shows possible features for the design of accessible information systems, such as computer-based testing systems.

D. Cultural, Ethnic, Racial, and Linguistic Diversity. The increasing cultural, ethnic, racial, and linguistic diversity within the United States, as well as the need to communicate with people throughout our increasingly interdependent global society, may add further impetus toward the provision of different ways of demonstrating communicative competence. Different spoken or written languages are different ways of demonstrating communicative competence; in tomorrow's domestic or international economy, a person's ability to communicate in multiple languages will be highly valued. Even if the English language remains the dominant (if not "official") language of North American society and the major language of international business, there will probably still be a significant need

spoken by the shop floor manager). Care must be taken to see that the accommodation does not change the nature of the construct being measured, thereby potentially reducing job-relatedness of the test. However, the increasing availability of computer workstations designed for universal access, as well as the increased availability of workplace accommodations specifically for people with disabilities, should gradually improve this situation. For example, computer technology could convert the written text of a technical manual to synthesized speech accessible by a person who is blind. Job-related assessments pointing to such disability-friendly work environments will have more latitude in the use of alternate communication modalities for people with disabilities. Organizations that design job-related assessments obviously have a responsibility to try to anticipate the work environments that will exist in the future, as well as to understand those that exist now.

[5]To successfully make accommodations for people with disabilities, a variety of issues regarding comparability between regular and accommodated administrations (Willingham et al., 1988, pp. 12-15) need to be addressed. Willingham distinguished between two components of comparability — score comparability and task comparability. Score comparability can be examined through studies of reliability, factor structure, item functioning, predicted performance, and admissions decisions. Analysis of task comparability requires an examination of the cognitive demands placed on the test taker, which may be affected by differences in content, by modification or accommodations, and by timing.

to tailor assessments to the cultural, ethnic, and other characteristics of the target audience. For example, in developing an English-language reading skills test that would be used by nonnative or international test takers, it might be desirable to moderate or even avoid reading passages that focus on events in North American history or culture (e.g., American Revolutionary War). High amounts of North American context and neglect of international context could provide an unwanted source of score variation among nonnative or international test takers. The same argument for tailoring assessments may be made for tests administered to members of minority cultures (e.g., Deaf culture, Hispanic American). To adequately assess English-language skills, the test developer may need to include content that draws on the cultural knowledge of the test taker.

3. Examine the Changes in Content and Skills Brought About by the Use of Technology in Academic Settings.

The TOEFL program should be alert to the possibility that technology may alter the kinds of content being communicated or the specific skills required in institutions of higher learning. For example, does the prevalence of electronic mail and spelling/style/grammar checkers change the kinds of writing that are most valuable for academic success? Students of the year 2000 will face an increasing need to communicate through electronic mail, voice mail, and other technologies. Does a different standard of correctness exist for these kinds of communications? Students of the year 2000 may have greater involvement in collaborative work and learning. How might this alter the kinds and combinations of listening, speaking, writing, and reading skills that are most essential to success in group work[6]? Does the growing use of multimedia warrant additional attention to other skills, such as visual-related skills, as well as to the ability to coordinate the use of diverse communication modalities and representational systems? What new or revised TOEFL services will be most helpful in responding to these changing needs? These and other possible changes should be investigated.

4. Look for Opportunities to Integrate Technology-Specific Context into Items and Tasks.

The TOEFL 2000 team should investigate ways of integrating technology-specific context into assessment items and tasks. It may be useful to develop items that explicitly refer to significant and common technologies. For example, a realistic problem of the year 2000 may ask a test candidate to compose an electronic mail message addressed to his or her instructor requesting clarification about a class assignment. Other possible technology settings for these problems might include some of those listed in Table 1 as having a "High" level of use in the year 2000 in all three kinds of institutions (e.g., text-based electronic mail and bulletin boards, personal computer and productivity software, such as word

[6]The importance of group work may vary widely across disciplines and levels of study. For example, perhaps in most disciplines, group work is probably more important in undergraduate course work than in graduate study, which usually is more individualized.

processors, grammar and style checkers, spreadsheets, and personal databases). In some cases, it may be feasible and valuable to incorporate commonly used tools into testing software. For example, students writing a short essay during an examination may be able to access spelling and style checkers, so that their demonstration of skills parallels the ways in which they will communicate in the real world. Regardless of which method or combination of methods is chosen, the TOEFL program must ensure that appropriate measurement models are developed to allow scoring and interpretation of the scores to its clients.

5. Uncover Emerging Trends and Monitor the Rate of Change.

As the TOEFL 2000 group continues its planning, it should undertake investigations similar to this one every few years, to uncover emerging trends and to monitor the rate at which the predicted changes are occurring.

This page intentionally blank

References and Bibliography

1992 Enrollment by race at 3,300 institutions of higher education. (1994, February 23). *The Chronicle of Higher Education*, A31.

Albright, M. J., & Graf, D. L. (1992). Instructional technology and the faculty member. *New Directions for Teaching and Learning, 51*, 7-14.

Association of Research Libraries, Systems and Procedures Exchange Center. (1992, July/August). *The emerging virtual research library*. Flyer 186.

Batson, T. (1994, February 14). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). TMOTF revision.

Batson, T. (1994, April 13). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Hypotheses from TMOF Phase I.

Baycroft, M. (1994, February 15). *New online, non-degree credit courses from The University of Western Ontario*.

Bennett, R. E. (1993). On the meanings of constructed response. In R. E. Bennett & W. C. Ward (Eds.), *Construction versus choice in cognitive measurement: Issues in constructed response, performance testing, and portfolio assessment* (pp. 1-27). Hillsdale, NJ: Lawrence Erlbaum.

Bennett, R. E. (1993a). Toward intelligent assessment: An integration of constructed-response testing, artificial intelligence, and model-based measurement. In N. Frederickson, R. J. Mislevy, & I. Bejar (Eds.), *Test theory for a new generation of tests* (pp. 99-123). Hillsdale, NJ: Lawrence Erlbaum.

Bennett, R. E. (1995). *Computer-based testing for examinees with disabilities: On the road to generalized accommodation* (RM-95-1). Princeton, NJ: Educational Testing Service.

Bennett, R. E., Ward, W. C., Rock, D. A., LaHart, C. (1990). *Toward a framework for constructed-response items* (RR-90-7). Princeton, NJ: Educational Testing Service.

Bertram, B. C. (1993). *Network-based classrooms: Promises and realities*. New York: Cambridge University Press.

Blystone, R. V. (1993, May-June). Teaching in the digital republic. *Academe*, 39-41.

Boynton, G. R. (1994, March 1). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Project Gutenberg.

Cage, M. C. (1994, January 26). Beyond the B.A. *The Chronicle of Higher Education*, A29-A31.

Carnegie Foundation for the Advancement of Teaching. (1987). *A classification of institutions of higher education*. Princeton, NJ: California/Princeton Fulfillment Services.

Cartwright, G. P. (1993, September/October). A matter of access. *Change*, 66-69.

Cavalier, R. (1994, March 13). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Faculty use of info tech.

College Board. (1990). *Coordinator's notebook for the computerized placement tests*. Princeton, NJ: Educational Testing Service.

Collison, M. N.-K. (1992, March 18). Many colleges report increase in applications for next fall.

CPB/WGBH [CPB/WGBH National Center for Accessible Media]. (1993). *Guidelines for producing accessible multimedia for deaf and hard-of-hearing students*. Boston, MA: CPB/WGBH National Center for Accessible Media.

Dede, C. (1993). Distance education. Trends and Forecasts. *EDUCOM Review, 28*(6), 35-36.

DeLoughry, T. J. (1992, September 23). Crucial role seen for technology in meeting higher education's challenges. *The Chronicle of Higher Education*, A21-A22.

DeLoughry, T. J. (1994, February 9). Television as a teaching tool. *The Chronicle of Higher Education*, A25.

DeLoughry, T. J. (1994, February 23). Unconnected. High network costs and low interest keep many off the Internet. *The Chronicle of Higher Education*, A19-A20.

Denning, P. J. (1993). Education for the age of collaboration. *EDUCOM Review, 28*(6), 20-25.

Doucette, D. (1990). The community college and the computer: Behind widespread integration into instruction. *Academic Computing, 4*(5), 12-14, 51, 54-56.

Educational Testing Service. (1994). Press release issued to PRNewswire, 12/31/94, 10:38 A.M. Re: Lawsuit filed to prevent test preparation firm from continuing to steal questions.

Educational Testing Service. (1994a). Accuplacer: A better measure of student success. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994b). Computer-based assessments at work. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994c). Computer-based testing and the needs of people with disabilities. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994d). *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994e). Computerized adaptive tests. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994f). The GRE General Test: Improving measurement. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994g). NCLEX: Nurse Licensure Examination: The changing world of nurse licensing. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Educational Testing Service. (1994h). Praxis I/LearningPlus: Access and quality in teacher education. *Computer-based testing: From multiple choice to multiple choices*. [Brochure]. Princeton, NJ: Educational Testing Service.

Ehrmann, S. (1994, February 7). *Texts, etc.* Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Response to Cavalier's comments about "natural candidates approach."

Ehrmann, S. (1994, March 13). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Valuable viable software project.

Ehrman, S. (1994, April 5). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). The economics of valuable viable software.

Evangelauf, J. (1992). Enrollment projections revised upward in new government analysis. *The Chronicle of Higher Education, 38*(20), A35-36.

Facts and Figures on U.S. Higher Education. (1993, August 25). *The Chronicle of Higher Education*, Almanac issue.

Facts and Figures on U.S. Higher Education. (1994, September 1). *The Chronicle of Higher Education*, Almanac issue.

Fawson, E. C., & VanUitert, D. D. (1990). The technology classroom. Alternatives for future planning. *Tech Trends, 35*(4), 1-2, 30-34.

Foa, L. J. (1993). Technology and change: Composing a four-part harmony. *EDUCOM Review, 28*(2), 27-30.

Frederiksen, J. R., & Collins, A. (1990). *A systems approach to educational testing*. Technical Report No. 2. New York: Center for Technology in Education.

Fritzsche, D. J. (1994, February 17). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Classroom technology.

Garland, V. E. (1990). Computers in 2001: Preparing educational administrators. *Tech Trends, 35*(3), 17-22.

Garson, G. D. (1994, March 11). Info tech penetration. Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Trends in rate of adoption/penetration of info tech into academic usage.

Gifford, B. R. (1992, June 10). *Where is the knowledge? Knowledge management, research and pedagogy in the electronic age*. Paper presented at the meeting of The Special Libraries Association 83rd Annual Conference, San Francisco, CA.

Gilbert, S. (1994, February 24). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Role of academic departments.

Gilbert, S. (1994, April 7). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Hypotheses from TMOTF Phase I.

Gilbert, S. W. (1993, March/April). Can connectivity support community? Another challenge for information technologies. *EDUCOM Review, 28*(2), 44-46.

Gilbert, S. W. (1994, February 10). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Request for help and TMOTF hypothesis.

Gilbert, S. W. (1994, March 22). *Being there*. Presentation to Board Chairs, Spelman College, Atlanta, GA.

Gilleland, J., & Johnson, N. (1992). Facilities for the future. *American School and University, 64*, 44B-44D.

Goeking, K. (1994, March 8). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Ideas for Board Chairs.

Green, K. C. (1994). *Campus computing 1994: The USC national survey of desktop computing in higher education*. Los Angeles: University of Southern California.

Havholm, P. (1994, February 9). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Intertextuality and hypertext in class.

Heterick, R. C., Jr., & Sanders, W. H. (1993). From plutocracy to pluralism. Managing the emerging technostructure. *EDUCOM Review, 28*(5), 22-28.

Holden, M., & Mitchell, W. (1993). The future of computer-mediated communication in higher education. *EDUCOM Review, 28*(2), 31-37.

Institute for Research on Higher Education. (1993, September/October). Landscape. The changing faces of the American college campus. *Change*, 57-60.

Jacobson, R. L. (1994, February 2). Connecting the schools. *The Chronicle of Higher Education*, A17-A18.

Jensen, R. E. (1993, July-August). The technology of the future is already here. *Academe*, 8-13.

Kaplan, R. M. (1992). *Using a Trainable Pattern-Directed Computer Program to Score Natural Language Item Responses* (GRE Board Professional Report No. 89-19P). Princeton, NJ: Educational Testing Service.

Kaplan, R. M., Bennett, R. E. (1994). *Using the Free-Response Scoring Tool to Automatically Score the Formulating-Hypotheses Item* (GRE Board Professional Report No. 90-02bP). Princeton, NJ: Educational Testing Service.

Kaplan, R. M., Burstein, J., Trenholm, H., Lu, C., Rock, D., Kaplan, B., & Wolff, S. (1995). *Evaluating a Prototype Essay Scoring Procedure Using Off-the-Shelf Software* (RR-95-21). Princeton, NJ: Educational Testing Service.

Kay, A. C. (1991, September). Computers, networks and education. *Scientific American*, 138-148.

Kolker, R. P. (1994, March 10). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Response to Willut's estimate of info tech penetration on some campuses.

Lamb, A. C. (1992). Multimedia and the teaching-learning process in higher education. *New Directions for Teaching and Learning, 51*, 33-42.

Leeds, M. (1994, March 11). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Slowdown in use of info tech.

LeGates, J. (1994, April 18). The information highway. "Tools We Can Use" seminar series, Educational Testing Service.

Lewis, C., & Sheehan, K. (1990). Using Bayesian decision theory to design a computerized mastery test. *Applied Psychological Measurement, 14*(4), 367-386.

Lombardi, J. V. (1994, March 2). Campuses need not wait for snazzy new technology to enter cyberspace. *The Chronicle of Higher Education*, A48.

Lunz, M. E., & Bergstrom, B. A. (1994). An empirical study of computerized adaptive test administrative conditions. *Journal of Educational Measurement, 31*(3), 251-263.

Lunz, M. E., & Bergstrom, B. A. (1995). *Equating computer adaptive certification examinations: The Board of Registry series of studies*. Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

MacDonald, G. (1993). Wireless handheld devices. Trends and forecasts. *EDUCOM Review, 28*(6), 35-36.

Manning, M. (1994, March 17). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Response to issues for Board Chairs.

Miller, M. J. (1994, March 29). The long and winding road. *PC Magazine*, 79-80.

Mislevy, R. J. (1993). A framework for studying differences between multiple-choice and free-response test items. In R. E. Bennett & W. C. Ward (Eds.), *Construction versus choice in cognitive measurement: Issues in constructed response, performance testing, and portfolio assessment* (pp. 75-106). Hillsdale, NJ: Lawrence Erlbaum.

Mislevy, R. J. (1993a). Foundations of a new test theory. In N. Frederickson, R. J. Mislevy, & I. Bejar (Eds.), *Test theory for a new generation of tests* (pp. 19-39). Hillsdale, NJ: Lawrence Erlbaum.

Moran, C. (1993, April). The winds, and the costs, of change. *Computers and Composition, 10*(2), 35-44.

The Nation. (1993, August 25). Colleges with most freshman National Merit Scholars, financial aid to full-time students, campuses with largest enrollments. *The Chronicle of Higher Education,* Almanac issue, 12.

Norman, D. (1994, March 9). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Course pack hypothesis.

Oettinger, A. (1993). Computer applications. Trends and Forecasts. *EDUCOM Review, 28*(6), 35-36, 38.

Paulsen, M. (1992). *From bulletin boards to electronic universities: Distance education, computer-mediated communication and online education* (Research Monograph #7). The American Center for the Study of Distance Education at the Pennsylvania State University and The Annenberg/CPB Project, pp. 47-55.

Prokasy, W. F. (1991). The new pedagogy: An essay on policy and procedural implications. *Innovative Higher Education, 15*(2), 109-115.

Ranieri, P. (1994, March 13). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Response to Candice Willut.

Ranieri, P. (1994, March 22) Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Response to Larry Levine about administrative challenges to implementing info tech.

Reeves, P. (1994, March 3). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Issues of intrinsic and extrinsic rewards for faculty.

Reinhardt, A. (1994, March). Building the data highway. *Byte, 19*(3), 46-74.

Reuter America Inc. (1994). Lawsuit filed against school test prep firm. (Educational Testing Service press release to Reuter America.) (January 31, 1994).

Ricart, G. (1993). Connecting the networking dots. *EDUCOM Review, 28*(5), 36-41.

Riffee, B. (1994, March 13). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Need to make it easy for the faculty for penetration of info tech.

Ringle, M. (1993). Academic and administrative computing. Trends and Forecasts. *EDUCOM Review, 28*(6), 35, 37.

Sammons, M. C. (1994, February). Motivating faculty to use multimedia as a lecture tool. *T.H.E. Journal*, 88-90.

Schneiderman, B. (1993). Education by engagement and construction: Experiences in the AT&T teaching theater. In H. Maurer (Ed.), *Educational multimedia and hypermedia annual* (pp. 471-479). Charlottesville, VA: Association for the Advancement of Computing in Education.

Schneiderman, B. (1994, February 14). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Request for help and TMOTF hypothesis.

Schwartz, H. J. (1993, March/April). Planning for new majority students. *EDUCOM Review, 28*(2), 38-42.

Scott, D. K., & Awbrey, S. M. (1993, July/August). Transforming scholarship. *Change*, 38-43.

Seamster, John. (1994, April 4). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). The economics of valuable, viable software.

Shea, C. (1994, January 26). Women and minorities led the way in a year of slow enrollment growth. *The Chronicle of Higher Education*, A32.

Sheehan, K., & Lewis, C. (1992). Computerized mastery testing with nonequivalent testlets. *Applied Psychological Measurement, 16*(1), 277-292.

Sheekey, A. D. (1993). Electronic communications. Trends and forecasts. *EDUCOM Review, 28*(6), 35, 37-38.

Snow, R. E. (1993). Construct validity and constructed-response tests. In R. E. Bennett & W. C. Ward (Eds.), *Construction versus choice in cognitive measurement: Issues in constructed response, performance testing, and portfolio assessment* (pp. 45-60). Hillsdale, NJ: Lawrence Erlbaum.

Solomon, M. B. (1994, February). What's wrong with multimedia in higher education? *T.H.E. Journal*, 81-83.

Soloway, E., Guzdial, M., & Hay, K. E. (1993). Reading and writing in the 21st century. *EDUCOM Review, 28*(1), 26-29.

Spagna, G. (1994, February 7). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Splitting hairs.

Spagna, G. (1994, February 25). Memo to multiple recipients of AAHESGIT AAHESGIT@GWUVM.BITNET. Role of academic departments.

Spanos, G., & Smith, J. J. (1990). Closed captioned television for adult LEP literacy learners. *ERIC Digest*. Washington DC: Adjunct ERIC Clearinghouse on Literacy Education for Limited-English-Proficient Adults.

Stocking, M. L., & Swanson, L. (1993). A method for severely constrained item selection in adaptive testing. *Applied Psychological Measurement, 17*(3), 277-292.

Teaching with Technology. (1994, February 2). *The Chronicle of Higher Education*, A19.

Theall, M. (1994, February 25). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Role of academic departments.

Underwood, J. H. (1993, August/September). The lab of the future. *AACC Journal*, 33-39.

Vanderheiden, G. C. (1994). Use of multiple parallel interface strategies to create a seamless accessible interface for next-generation information systems. Available FTP: Hostname: trace.wisc.edu Directory: pub/text/tracepap/seamless.txt.

Wainer, H., & Thissen, D. (1994). On examinee choice in testing. *Review of Educational Research, 64*, 159-195.

Weingarten, R. (1993). The national information infrastructure. Trends and Forecasts. *EDUCOM Review, 28*(5), 51, 53.

Wiggins, G. (1990). The case for authentic assessment. *ERIC Digest*. Washington DC: American Institutes for Research.

Willingham, W., Ragosta, M., Bennett, R. E., Braun, H., Rock, D. A., & Powers, D. E. (1988). *Testing handicapped people*. Boston, MA: Allyn and Bacon.

Wilson, D. L. (1992, December 2). Community colleges seen leading in instructional use of computers. *The Chronicle of Higher Education*, A21-A23.

Wilson, J. L. (1994, March 13). Memo to multiple recipients of list AAHESGIT (AAHESGIT@GWUVM.BITNET). Comments on Willut's conjectures re: faculty use of computers in classroom.

This page intentionally blank

Appendix A: Growth Areas in Computer-Based Testing

This section focuses on a few areas of possible significant growth by the year 2000 and beyond. The following categories are not mutually exclusive. In addition, significant growth may occur in any or all of these areas, but may not, individually or collectively, predominate in computer-based testing.

Instructional Assessment. Considerable growth is expected in instructional assessments in colleges and universities. Computerized assessments with instructional feedback can help free instructors to give personalized attention to other educational needs. With greater access to networked computers, students will increasingly be able to take quizzes and other course examinations on computers. Students will have more flexibility regarding the time when certain instructionally-related tests are taken[7].

Computer-Adaptive Testing. Computer-adaptive testing quickly zeros in on ability levels, reducing testing time by half or better when compared with nonadaptive tests (either computerized or paper-and-pencil tests). Computer-adaptive testing can also provide better security than nonadaptive tests by giving examinees somewhat different sets of questions yet providing a way to score all administrations on the same scale. Computer-adaptive testing is currently being successfully used in a variety of operational settings that can involve students enrolled in colleges and universities. These settings include placement (e.g., the Computerized Placement Tests Program [College Board, 1990; ETS, 1994a]; graduate school admissions [Graduate Record Examination — GRE — General Test [ETS, 1994f] and professional licensure/certification [National Council for Licensure Examination — NCLEX — for nursing licensure ETS, 1994g]; Praxis I: Academic Skills Assessments [ETS, 1994h]; American Board of Clinical Pathologists [Lunz & Bergstrom, 1995])[8].

Commercial software that allows institutions to develop their own adaptive tests is currently available (e.g., MicroCAT Testing System [Assessment Systems Corporation, 1992]). The adaptive capabilities of such systems, however, are often relatively underused in favor of more conventional computer-based testing capabilities, e.g., straight linear or randomized administration) and item (question) banking. Relatively few institutions possess the personnel and other resources for developing and maintaining computer-adaptive testing systems without specialized outside assistance, and this is not expected to change dramatically by the year 2000 (Way, personal communication, September 12, 1995).

Automated Constructed-Response Scoring. We expect growth in constructed response scoring, where the term "constructed-response" minimally denotes that the question or prompt requires the examinee to generate (i.e., to construct) a response instead of to select from a small set of options (Bennett, 1993). Constructed responses may be short or extended, ranging from short answers of a word or two, sentences, and essays, to computer programs and other complex performances (such as artistic performances,

[7]In its broadest sense, this "instructional assessment" category includes computer-based tests with some amount of instructional feedback, but also most computer-based instruction, since most computer-based instruction includes an assessment component.

[8]The "Praxis I: Academic Skills Assessments" measures the basic reading, writing, and mathematics skills that college students need to enter a teacher preparation program. It is the first component in a series of professional assessments entitled "The Praxis Series: Professional Assessments for Beginning Teachers®" (ETS, 1994h).

troubleshooting operations, and complex team activities). Research is progressing on the automated scoring of constructed responses, including computer-based scoring of short English-language answers (Kaplan, 1992; Kaplan & Bennett, 1994; Kaplan et al., 1995) and short computer programs (Bennett, 1993a). Continued progress toward large-scale operational use of automatic scoring of complex constructed responses is expected.

Multimedia. Multimedia will begin to play a more prominent role in computer-based testing. Drawings, animations, still photos, motion clips, and sound will become more common as stimuli (i.e., prompts or questions) for questions. Instructional assessments, in particular, will employ multimedia to develop information-rich learning and assessment environments.

Multimedia can be combined with other technologies to provide "virtual" environments within which the examinee/learner can demonstrate his or her skills. Such systems will combine new measurement approaches with multimedia and a variety of special input and output techniques (e.g., goggle, glove, or other technologies). Many of the actions or "responses" within such an environment would probably be "constructed" (as opposed to "selected") and would thus require appropriate constructed-response scoring approaches. Such systems may also require a capacity to adapt to the skills and knowledge of the particular examinee/learner. Such virtual environments represent an exciting frontier in computer-based assessment. By the year 2000, such systems are expected to be used more in research than in operational settings. Such systems, but without the complete educational measurement infrastructure, may be even more common in extracurricular entertainment settings.

Distance Assessment. Increasing integration of computer, television, cable, and telephone technologies will dramatically increase the potential for distance-supported, computer-based testing. For example, tests can be administered over the Internet/Web. Desktop videoconferencing technologies, mediated by local area networks, switched phone lines (analog or digital), or other technologies, will enable one-on-one assessment between a diagnostician and a client or will even allow real-time assessment activities between people at three or more locations.

Appendix B: Design for Accessibility for People with Disabilities

This appendix outlines some considerations in the design and development of accessible computer-based tests.

ETS and the programs should strive to design and develop products and services that are accessible by all people, including people with disabilities. While it is not possible to make everything usable by everyone, it is possible to develop strategies that will make tests and related services usable by many people with disabilities.

Design changes intended to improve disability access can prove useful for the wider population. For example, curb cuts on sidewalks were intended to accommodate wheelchair users, yet they have proved a great boon to other individuals, including mothers with strollers, people temporarily on crutches, and people of all ages and situations who have difficulty mounting or descending steps.

Features for Accessible Information Systems

What features should be considered in the design of accessible information systems as computer-based testing systems? The following features for accessible design of information systems are adapted from a list by Gregg Vanderheiden of the Trace Research and Development Center of the University of Wisconsin at Madison (Vanderheiden, 1994):

User Type/ Characteristics	Features
All Users	• Operable using mouse, touch screen, or from the keyboard, at user option • Friendly, easy-to-understand graphical interface • Ability to have sounds visually depicted for noisy environments or no-sound environments (e.g., libraries) • Zoom data text for easy reading
Users with... ...manipulation difficulties	• Operable completely from keyboard • Print to paper or print to disk
...somewhat low vision	• Ability to zoom data text, with fonts from 12 point to 48 point • Operable from keyboard if mouse is difficult to see
...blindness	• Operable completely from keyboard • Full voice feedback mode (does not require screen-reading software)
...cognitive/language impairments	• Easier-to-understand graphic interface • Touch screen capable • Voice output mode
...hearing impairments	• Option for all auditory information to be presented visually

Accessible design of an information system often entails the use of alternative and/or redundant ways of interacting with the system. For example, audio material is depicted visually, visual material is depicted using audio, and the system may be controlled by mouse, keyboard, or touch screen.

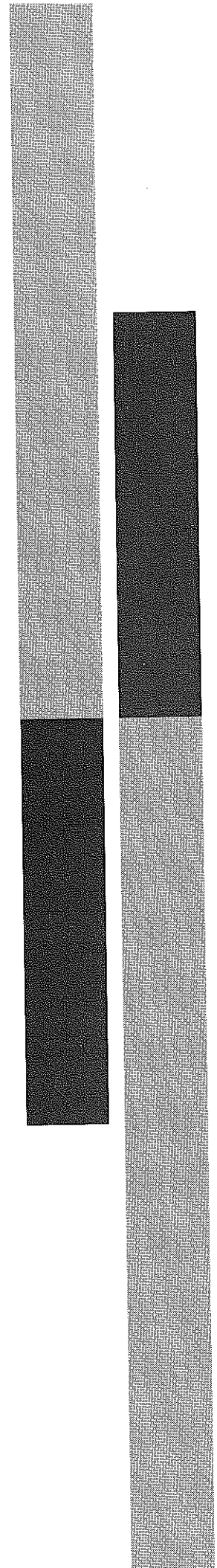
Extended Time

Extended time is the accommodation most commonly granted to test takers with disabilities, yet this accommodation can present a challenge to assessment task comparability between disabled and nondisabled test takers.

Bennett (1995) suggests that extended time should be investigated as a feature provided to all test takers for certain tests. As such, extended time would become a "universal design" feature — what he terms a "generalized accommodation" — for those tests. Bennett specifically suggests that, particularly in computer-based tests, extended time could be provided to all test takers while possibly maintaining the essential measurement properties of the test for both disabled and nondisabled test takers (although comparability to any version administered without extra time may be impaired).

System Flexibility

A computer-based testing system should be flexible enough to enable and disable a variety of accommodation features. An accommodation that does no harm to the measurement characteristics of the test should be investigated as a potential generalized accommodation available to all test takers.



Cover Printed on Recycled Paper

58701-15455 • Y38M0.5 • 253710 • Printed in U.S.A.