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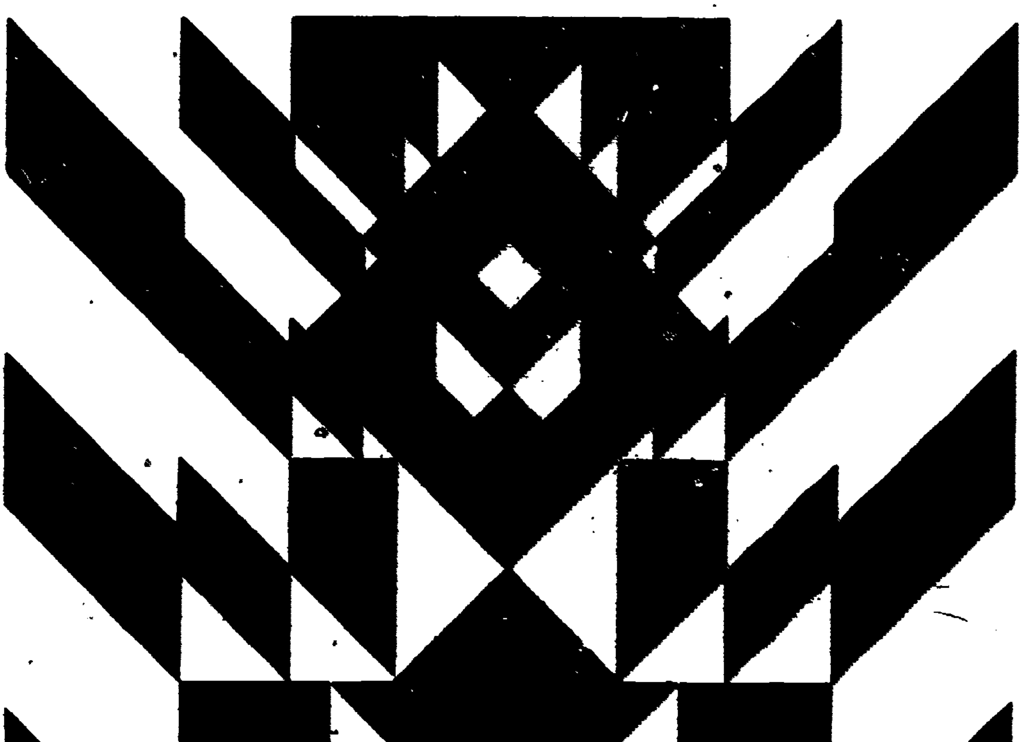
ABSTRACT

The articles in this collection identify and discuss challenges facing community colleges as they attempt to implement the new microcomputer technology for instructional and administrative purposes. The collection includes: "The Microcomputer Revolution and Its Impact on Community Colleges," by Donald A. Dellow and Lawrence H. Poole; "Microcomputers in Science Education," by Laurence D. Spraggs; "Behavioral Science Applications of Microcomputers," by Clifford Roger Dillmann; "The Microcomputer in Business Education," by David R. McKay; "Computer-Assisted Writing," by Robert L. Levin; "A Microcomputer-Based Computer Science Program," by Larry D. Compeau; "Microcomputer Applications for Community College Administrators," by Dale O'Daniel; "Application of Micros in Libraries and Learning Resource Centers," by Eleanor M. Carter; "Computer-Assisted Adult Learning and the Community College Response," by Barry Heermann; "The Use of Microcomputers in the Continuing Education of Community and Professional Constituencies," by James E. Garmon; "Choosing a Microcomputer for Use as a Teaching Aid," by Cheryl Visniesky and Joan Hocking; "The Future of Microcomputers in Community Colleges," by Dale F. Campbell and William L. Ballenger; and "Sources and Information: Microcomputers," by Jim Palmer. (LAL)

NEW DIRECTIONS FOR COMMUNITY COLLEGES

Microcomputer Applications in Administration and Instruction

Donald A. Dellow, Lawrence H. Poole, *Editors*



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ARTHUR M. COHEN, *Editor-in-Chief*
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Contents

Editors' Notes

The primary purpose of this volume is to identify the challenges faced by community college educators as they attempt to implement the new microcomputer technology. There is a strong sense of the pioneering spirit in this field, where there are no long-term experts. Instructors or administrators who want to learn about using microcomputers in their field have very little literature on which to rely. Reading a few short articles, attending a few convention presentations, and having the courage to give it a try are the hallmarks of the initiated. That is the spirit in which most of the authors of this volume share their experiences with the new technology. In two chapters, educators who work with community colleges give some perspectives from their vantage points from outside. In all but two cases, the manuscripts were submitted to the editors with tell-tale dot matrix printing. Some chapters were sent by modem, one across campus, another across country. In all, the authors seem to represent what is happening on the community college scene. One thing shines through—the authors' excitement and enthusiasm as they share their experiences and hopes for this new technology. They acknowledge the frustrations and false hopes. Some authors present challenges. But, it is still clear that it is a great time to be a professional educator in the community college.

In Chapter One, the editors review the ways in which microcomputer technology affects the community college. They identify the issues with which faculty and administrators must deal if they want to stay current and remain credible with their clientele.

In the next three chapters, Larry Spraggs, Cliff Dillmann, and David McKay present their experiences in implementing microcomputer technology in the sciences, the behavioral sciences, and business education, respectively. Each author takes an optimistic view of the radical and long-needed changes that the new technology can bring to his field. Software selection and the specific applications of three general types of software—word processing, spreadsheets, and data base management programs—for both faculty and students are themes in all three chapters.

In Chapter Five, Bob Levin shares some of the positive effects that he has seen in his work with computer-assisted writing. His writing shows that he has been in the lab and shared the excitement of students who found that writing was not sheer drudgery. He gives some practical hints on setting up computer-assisted writing programs at other colleges.

In Chapter Six, it becomes clear that even individuals with a computer science background can have problems with microcomputers. Larry Compeau describes in detail how his college implemented a computer science program with microcomputers as the primary computer resource. Larry shares detailed information that can help others who wish to consider this alternative. He also gives us an idea of the politics that we can anticipate when our students transfer to mainframe-oriented colleges.

In Chapters Seven and Eight, Dale O'Daniel and Eleanor Carter show how two college administrators have integrated microcomputers into their areas of responsibility. Dale O'Daniel reviews the ways in which his work and that of the college have benefited from use of microcomputers. Shortened budget preparation time, professional-looking correspondence, and electronic transfer of information are some of the uses that he describes. Eleanor Carter challenges learning resource center personnel to exercise leadership to ensure that microcomputers become a major learning resource. She describes strategies that make microcomputer labs work.

In Chapters Nine and Ten, Barry Heermann and James Garmon address the application of microcomputers to adult learners in traditional and nontraditional settings. Barry Heermann describes why he believes community colleges can and must use microcomputers to provide adults with self-paced, individualized learning experiences. James Garmon describes off-campus nontraditional learning situations that colleges are offering. Together, the two chapters challenge community college educators to think beyond use of microcomputers in campus labs for traditional educational purposes.

In Chapter Eleven, Cheryl Visniesky and Joan Hocking provide some valuable advice on how to select a microcomputer for instructional use. They pose a number of questions that will assist the would-be computer buyer in making a wise purchase.

Unfortunately, this volume is too short to cover all the possible discipline areas affected by the new technology. We hope that the insights conveyed about areas covered will provide direction for those in other areas who are trying to forge ahead. It will be clear to the reader that all the authors have faced certain common problems. Solving those common problems would put us light-years ahead. Others may assemble a volume covering areas omitted from this one.

In Chapter Twelve, Dale Campbell and William Bellenger review some of the research on uses for microcomputers in community colleges and attempt to anticipate future developments. They review certain bellwethers in education that offer a basis for predicting how community colleges will use technology.

The last chapter by Jim Palmer provides information on additional resources that are available for educators interested in the microcomputer applications.

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Editors

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Community college faculty and administrators need to assess how microcomputer technology will affect traditional instructional roles, values, and activities.

The Microcomputer Revolution and Its Impact on Community Colleges

Donald A. Dellow, Lawrence H. Poole

One of the most pressing concerns in education today is the impact that microcomputers will have on the educational bureaucracy. By definition, bureaucracy is slow to change. But, the new microcomputer technology seems to require rapid change. The educational bureaucracy never really integrated previous educational technologies, such as programmed learning, educational television, and individualized learning. Can that same bureaucracy avoid this new challenge?

A recent, statewide computer conference that we attended showed us that educators are excited about the promise and potential of microcomputers. Industry, parents, and even computer-literate toddlers have prodded educators to get with the times, and we now seem to be responding to the many applications that we see for this new technology. Dreamers talk of providing the truly individualized education that we forever espouse. Pragmatists hope that microcomputers will take some of the drudgery out of certain monotonous tasks. Administrators expect to control the tide of paperwork, and kids revel in the possibility of having Pacman in the classroom as a reward for hard work. Each has

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his or her own vision for a future with computers, but we all believe that the microcomputer will revolutionize the way we help people learn.

The community college will be affected like all other levels of education. Faculty will find it difficult to avoid using microcomputers, whether stand-alones or networked to mainframes, to transmit information or provide supplementary review. Vocational and technical faculty are finding that industry is outstripping them in using computers to provide individualized training. Administrators will need to become sophisticated about sending data and reports across telephone lines to statewide data bases and networks. Secretaries will have to learn how to use new microcomputer-based and networked equipment. Learning resource center personnel will need to add electronic media and data bases like CompuServe to their repertoire. In reviewing the ways in which microcomputers may affect community colleges, it seems safe to say there is going to be a revolution on campus.

Keeping Up with New Technology

One major problem associated with the new microcomputer technology is the speed with which it develops and changes. As Naisbitt (1982) notes, new technology is first used to make everyday activities a little easier or to extend people's effectiveness. Next, it is used to create new technology, which creates a kind of exponential growth rate in the new area. This exponential growth rate creates indecision among administrators and faculty about the purchase of equipment and software. Should we buy today or wait until something better comes along? As new equipment continues to be released, we are left wondering whether and when the process will slow.

The indecision of buyers is equaled by that of software and courseware developers. With the release of each new microcomputer product, there is concern about the market share that the new product will capture. The recent release by Apple of the Macintosh is a good example. Will the new thirty-two-bit technology and the sophistication of Lisa software persuade customers to abandon IBM Personal Computers, Commodore 64s, Radio Shack Model IIIs, or even the Apple IIe? When will IBM come out with a thirty-two-bit machine to rival the Macintosh? The pace of technological advance may well be one of the factors that slows the development of good software for the use in community colleges. Software and courseware companies will not risk development dollars for products as long as the equipment is changing as fast as it recently has.

In recent research on the use of microcomputers in small two-year colleges across the nation, Bender and Conrad (1983) reported that 91 percent of their responding sample (168) was using microcomputers on campus. Bender and Conrad found that a variety of microcomputer brands were being used, including a number that are no longer on the market. Reviewing the implications of their findings, they recommend that institutions adopt a systematic approach in selecting equipment and software and that they establish policies and guidelines to provide control and direction.

The beginning of microcomputer purchasing control may emerge at state levels. In Florida, for instance, community colleges must now clear all computer equipment requests through the state education department before purchase. This trend toward standardization of equipment by regulation may offer educators and software developers the incentive needed to implement the technology and diminish their apprehension about missing out on new items.

Campus as Battleground

The enthusiasm for microcomputers is a two-edged sword. When people, particularly college professors, become enthused, they begin to feel ownership, and the territorial imperative begins to be felt. At one time, data processing departments, both administrative and instructional, controlled the computing power on campus. Now that every individual department can buy microcomputers, battles over which department should control the microcomputer lab and teach microcomputer literacy courses are raging. On one campus, the fight between the data processing and academic departments over control of computer courses was so bitter that a new academic computing support department was established. The authors of the subsequent chapters in this book make convincing arguments for placing control of microcomputer labs in learning resource centers, business education departments, and computer science departments. Since there is not enough money to fund all requests at once, what rationale does one follow in making decisions over control of the new technology?

Challenges Facing Community Colleges

Community college faculty and administrators who have been looking toward the future see challenges appearing on the horizon. It is not possible to chronicle here all the areas that require action in the near future, so we will identify the more pressing and direct readers to other chapters in this book for additional detail.

Computer Literacy. Although the term *computer literacy* is still open to interpretation, most experts would agree that the term implies four things: some familiarity with computer terminology, some knowledge of how computers work, some knowledge of the uses to which computers can be put, and some basic proficiency in the use of one or more kinds of computer. Under this definition, all community colleges face two problems in this area today. One is the need to provide enough training to ensure that all faculty, or at least a significant proportion of faculty, are computer-literate. The other involves computer literacy for graduating students. Due to widespread discussion of the importance of computer literacy as a new basic competence, should a course in computer literacy be a general education requirement? The two problems complicate each other. The fact that most campuses do not have computer-literate faculty makes it difficult to add computer literacy to the general education requirement for all students. This is undoubtedly the most pressing problem that community college leaders must solve if they are to address the remaining issues related to new technology. Readers may wish to participate in the nationwide computer literacy project that EDUCOM (P.O. Box 364, Princeton, New Jersey 08540; (609) 734-1768) is now conducting. The purpose of the EDUCOM project is to collect and share information on computer literacy activities in higher education.

Telecommunications. Long before most academics become computer-literate, the isolated microcomputer station that is presently state-of-the-art will yield to local area networking (LAN) and timesharing on mainframes via microcomputers. It doesn't take long for faculty, administrators, and students to see the many advantages of networking their micros to others or, better yet, to a mainframe. Work can be done at home and sent over the telephone lines to an office for processing. Administrators who use a microcomputer for a short while become impatient when they find that they cannot download information from a data base into VisiCalc or Lotus 1-2-3 for massaging. Communications channels—telephones for most of us—offer an instant connection with colleagues around the world.

One exciting event in working on this sourcebook involved the transmission via microcomputer and modem of Larry Compeau's chapter over the 1,500 miles between Saranac Lake, New York, and Marianna, Florida, where we were working. Although we had all used big data bases before, this was the first time that we had actually transmitted something important with a modem ourselves. Both the sender and the receivers were excited about their accomplishment. Subsequent revisions were sent back and forth a number of times. Another chapter was transmitted across campus via modem to save the secretary from retyping the manuscript.

In the state of Florida, schools and colleges can access two electronic networks with microcomputers. As Dale O'Daniel points out in Chapter Seven, one of these networks, the College Online Information Network (COIN), allows direct sharing of information, in both directions, with the state division of community colleges and all twenty-eight community colleges in the state.

The technology for networking local and distant computers is emerging fast. Administrators and faculty who do not purchase equipment with networking and telecommunications capabilities will soon be sorry. The possibility of an electronic classroom in which the student accesses a host computer on campus from home is fast becoming a reality. In the chapters that follow, several authors perceive an increase in the use of telecommunications as the next major step for education.

Videodisc Technology. The long-awaited videodisc technology seems to be approaching faster than most people predicted. It is now possible to integrate microcomputer technology with existing videodiscs to produce exciting lessons. A student sitting at a microcomputer terminal can work his or her way through a program that can access 58,000 frames on a videodisc. The lesson can use high-quality still photographs or film clips to illustrate its points. In Florida, one state agency has contracted with groups to produce videodiscs that can be used with microcomputers to provide staff with in-service training. Together, the microcomputer and the videodisc will make truly interactive instruction a possibility.

Control of Information. Bender and Conrad (1983) discuss an issue raised by the increasing numbers of microcomputers on campus: the control of information. Bender and Conrad believe that the democratizing effects of everyone's having the ability to manipulate data will create questions about who should have access to information. Information is now controlled by an administration, which generally shapes the data and presents them to insiders and outsiders alike. Serious questions can be raised about current levels of security of computer data bases and about the absence of policy on access. These concerns about control of information would best be worked out before major problems arise.

Contract Negotiations. Sooner or later, faculty will introduce the issue of microcomputer access into contract negotiations. Some faculty groups may decide that computers represent a threat and seek to keep them off the educational scene for as long as possible. Other faculty groups may want to negotiate for a microcomputer for every office or for personal computers that can be taken home. The issue of how the computer will affect faculty work load is sure to appear on the bargaining table soon. The possibilities are many.

Curriculum Changes. The microcomputer has potential for making significant changes in the way we structure the curriculum of the community college. When the impact of highly portable microcomputers, telecommunications, and interactive videodiscs is considered, the traditional curriculum of higher education would seem to be threatened. It will be more difficult for instructors to stand up in a classroom and convey information at a snail's pace when students can scan a computer monitor or speed through an interactive videodisc at their own pace, slower or faster than that of the conventional lecture. Complex computer simulations can give faculty and students a dynamic new structure that blends theory with personal involvement.

A number of chapters in this book speak to the biggest change that we can expect in the curriculum: Individual learners will sit at microcomputers, either at home or work, interacting with either disk-based or on line computer-assisted instructional materials. Students will come to campus only for lab experiences, examinations, or group interactions. Those who think that this prospect lies far in the future would shudder to read material the authors received from TeleLearning Systems, Inc., on the "Electronic University." For a nominal fee, students can sign up for a variety of courses that they can take in the comfort of their own home—or anywhere else there is a telephone. Nearly one hundred courses, costing as little as $45, can already be taken. The courses include Fundamentals of Music, Planning Cash Flow, English Literature, and Human Resource Management. Since the Electronic University offers no credit, colleges can develop and give their own courses through TeleLearning, or they can allow students to pay tuition and give credit for work completed in the courses it offers. The questions raised by this major change in the curriculum will confuse us for years. Faculty work loads, state funding formulas, flexible semesters, and quality control will challenge our best thinkers.

"The Road to Utopia?"

A recent editorial ("The Road to Utopia?" 1984, p. 5) provides an appropriate close: "It's time to stop kidding ourselves about the long-range benefits of establishing computer technology in college classrooms. Making every person computer-literate will not lead to utopia. Nor is it accurate to claim that computers can miraculously simplify the challenging task of acquiring knowledge. This is wha omputer manufacturers would like us to believe, however, and schools and universities have succumbed to the hype."

These words are sobering. Undoubtedly, the same message will be expressed more often in the near future as concerned individuals begin to worry about putting too many eggs in one basket. The power of the technology is irresistible to a group of professionals who have had few new ideas or experienced few changes in the last two hundred years. It will be important for community college faculty and administrators to see that a balance of instructional strategies continues to be used on our campuses. It would be a shame to have the computer tyrannize college instruction in the 1990s in the way the lecture tyrannizes instruction today. It will be important to heed Naisbitt's (1982) concept that as people are exposed to greater levels of technology, there seems to be a corresponding need for greater human contact in other areas of their lives. As we move deeper into high technology, we should not be surprised to find that many people will still want to come to class or that they will want the best elements of today's classroom instruction to be retained. We can hope that the human need for concern, caring, and touch will continue to play the most important part in our lives.

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Computer applications have long been recognized in the sciences, but only recently has microcomputer technology made it possible for computers to reach the science classroom and provide computing power for not only the work of science but also the learning of science.

Microcomputers in Science Instruction

Laurence D. Spraggs

The mathematical basis of both science and computer technology makes the two fields natural allies. The data dependence of science and the remarkable data manipulation ability of the computer go hand in hand. However, only the microcomputer has allowed computer technology to reach the undergraduate classroom. Soon, almost every classroom will have access to a microcomputer, and it is logical that the longtime partnership between science and the computer will ensure that the science classroom leads the way.

The community college is playing a pioneering role in the development of microcomputing applications, as a result of several factors. Community colleges have traditionally not had the funds necessary to purchase a large mainframe computer, as the large research-oriented universities have. The development of the microcomputer has made computing power available to the community college. In fact, individual departments can purchase computing equipment specific to their needs. The community college establishment, committed as it is to innovation and new ideas, has been quick to use micros in its educational programs. The mission of the community college has been another factor in its rapid acceptance of the new technology. The open-

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door policy that typifies community colleges results in a very heterogeneous student population. This heterogeneity necessitates at least some attempt to individualize instruction, and the microcomputer is very valuable for this purpose.

Applications

There are numerous science applications for microcomputers in community colleges. These applications use methods that other disciplines do, such as tutorial, drill and practice, and simulation. Another application that is particularly appropriate to the sciences is interfacing with laboratory equipment. However, to use microcomputers in the science classroom, type of equipment and logistics of use must be considered.

Simulation and Modeling. In science, many simple ideas are crucial to the understanding of larger concepts. All too often, students in the sciences have misconceptions concerning these simple, unifying ideas. Clearly, improvement of education as a whole depends on overcoming the basic, persistent misconceptions (Molnar, 1982). The opportunity to use simulation as an experiential process can help students to understand the difficult simple ideas.

Conceptual models have always played an important role in the sciences. Conceptual models represent real systems. By manipulating the model of a system, students become better able to understand the system represented. Computer simulation involves manipulating mathematical models of real systems.

Modern science instruction has been characterized by the inquiry method, and computer simulation opens up vast new areas to student-centered discovery in the process and ideas of science. Simulations allow students to manipulate objects and situations that they might otherwise not grasp. Existing simulations enable students to investigate the reproductive behavior of "tribbles"—beings from another planet—and to control an atomic reactor.

Real systems often have several components. Much of the difficulty that students have in understanding complex phenomena is due to their inability to deal with many variables at the same time (Rasch, 1983). Computer simulations enable students to manipulate numerous variables at one time. For example, programs that allow students to manipulate some of the parameters that affect an ecosystem are of enormous value in teaching about its complexities. With microcomputers, students can conduct experiments in the laboratory that would take years to accomplish in reality. Furthermore, simulations allow students to experiment with a number of different approaches to the solution of a given problem (Norberg, 1975).

Computers facilitate the process of inquiry by the speed with which they can process the information that students input (Grimm, 1983). The speed with which the computer can display its computations allows several values to be investigated for a parameter within a convenient period of time and thus allows students to better understand the role of that parameter (Randall, 1980). I have used a simulation program on osmosis that asks students repeatedly to change the concentrations of the solutions being tested. This allows them to collect large amounts of data in a short period of time. Actually performing the same type of experiment would require a whole lab period or more to get information concerning one solution concentration.

Microcomputer-based simulation and modeling can be implemented in science instruction in several ways. With appropriate equipment and class size, simulation can be used well in lectures. The ability to illustrate principles in graphic format, then to repeat these presentations with other parameters suggested by teacher and students can lead to productive dialogue in the classroom. After the lecture presentation, students can use the same programs in independent study. I have used many programs in this manner. Computer simulations make it possible to produce repeated growth curves with different parameters, to show nerve action potentials while making numerous changes in the parameters, or to animate molecular structures that can be constructed and then rotated to give a far better three-dimensional representation than any textbook or chart can.

The potential uses of simulation are even more numerous in the laboratory. On a practical level, the use of simulation in the science lab can save time and money as well as increase safety. Many laboratory exercises that involve long preparation and weeks of observation can be simulated in a single laboratory period. For example, genetic experimentation is time-consuming. However, genetic simulations with the computer are quick and easy on both the student and the teacher. Numerous programs are available that allow students to cross fruit flies, cats, birds, or dogs and collect statistically usable data on the genetic principles being demonstrated.

In courses where laboratory skill is an important objective, computer simulation can help students to prepare (Von Blum and Hursh, 1977). Simulations concerning the use of apparatus can also be very valuable as preparation for actual use. I have used programs that simulate pipette use, titration techniques, and serial dilution procedures. All have great merit in this respect. One caution is that "live" laboratory should be the preferred presentation when it is not costly, time-consuming, or dangerous (Pollack, 1976). In these ways, the wise use of simulation can add excitement and productivity to the science laboratory. Although simulation cannot replace live manipulation of equipment or organisms, it can increase efficiency in the use of these materials, and where cost or safety is a factor, it can legitimately take the place of such material.

Tutorial. Community colleges have heterogeneous student bodies. Such factors as tested aptitude, grade attainment, socioeconomic background, preparation, and life experience are more diverse among community college students than they are in any other group of college students (Thornton, 1972). In the sciences particularly, the diversity of community college students can have a significant effect on pedagogical approaches. Science courses at the college level tend to assume knowledge of certain basic mathematical and scientific principles as prerequisite. For instance, a college biology course assumes some knowledge of basic chemistry. In the community college, such assumptions are difficult to make, even when courses have requirements for entry. Mature students may have met the requirements ten or twenty years before. Under these circumstances, it is clear that instruction should be individualized. In the tutorial mode, computers have been shown to be very efficient in individualizing instruction (Kamm, 1983). Computers allow students to learn at their own pace, and they provide students with immediate feedback. More important, considering the community college student's schedule of work and family responsibilities, computers allow tutoring at convenient times.

In principle, a course can use tutorial instruction alone. However, the need for laboratory experience in science instruction makes this rare. Integration of a computer tutorial into an existing audio tutorial program is more typical. The addition of a computer tutorial to traditional instruction is probably the most common way which computer tutorials are used.

Many programs on the market provide tutorial material for use in science classes. My personal experience with such material has been disappointing. It is hard to imagine that any commercial tutorial program would meet my course objectives. However, there are numerous authoring systems that can be used to produce tutorial material. Authoring programs do not require any programming knowledge of the author. Most such programs are relatively easy to use and allow the author to concentrate on the content and pedagogy of the presentation.

The authoring systems that I have used pose questions that the author must answer. They ask such things as, Do you wish to require numerical answers? What is the correct answer to the question? Do you want to give any hints? I have found that providing hints and making responses to wrong answers that refer students back to their textbook or some demonstration material helps them not only to master the material but also to improve study habits.

I used a commercially available authoring system to construct a tutorial program as a learning aid for a class in human anatomy and physiology. The class was for nursing students only, and its composition was heterogeneous. Many students were returning to school after a long absence. The students used the tutorials enthusiastically and found that they were a great aid in guiding them through their study. Students who used the tutorial got better grades than students who did not. The questions I used in the tutorial were similar to those found in nursing registry exams. The students who used the tutorials were very successful when they took their board exams.

The advantage of the computer over a workbook or study guide for student tutorials lies in its ability to vary the learning experience for individual students. Good tutorial material should take advantage of the individualization that the computer allows. Properly produced material makes use of the computer's unique ability to display graphics and accomplish animation. The microcomputer is wasted if it is only an electronic page turner.

Drill and Practice. The computer is uniquely equipped to provide students with exercises of drill and practice. The computer has the ability randomly to provide drill exercises for students' use. Many basic skills are best learned this way (D'Attore, 1981). When standardized tests are used as a measure of achievement (which is often the case for students in fields where a registry exam is administered, as in many of the health professions), students with access to computer-assisted drill and practice show superior achievement (Vinsonhaler and Bass, 1972; Culp and Lagowski, 1971).

I have found that drill and practice is a very useful tool for teaching students in the health-related professions. Many students enter a nursing program after spending a long period of time raising a family and have not used their academic skills for many years. With strong pressure to complete the program and become employable as soon as possible, many students experience great anxiety when attempting to perform at the required levels. I have found that computer drill and practice exercises formatted to resemble exams help my students to lose a considerable amount of test anxiety, and the transition back to the academic scene becomes much easier.

Interfacing Microcomputers and Laboratory Equipment. The microcomputer has the potential to act as a universal laboratory instrument. It can generate signals, gather data, and display and analyze results. Furthermore, the cost of microcomputer-based instrumentation is less than the cost of most conventional equipment (Tinker, 1981). Combining this use with the numerous other applications to which a single microcomputer can be put, it becomes easy to see how microcomputers should be economically attractive to the community college.

Most microcomputers can be adapted for laboratory measurement by using an analog-digital converter. This allows the analog laboratory instrument to communicate with the digital computer and vice versa. Numerous manufacturers produce such interfacing equipment, and many laboratory instrument firms are making direct connection between their instrument and a microcomputer possible (Summers, 1983). For example, some manufacturers of analytical balances and spectrophotometers now produce such equipment with ports for connection with a microcomputer. Equipment is also available that allows a microcomputer to function as an oscilloscope with trace storage capacity. The teaching potential of this type of device seems enormous. The cost of purchasing such special equipment may gainsay some of my claims of economy. However, if the purchase of new equipment is planned, then the possibility of computer interfacing should be investigated.

Another approach is to take advantage of a built-in analog-digital interface that is relatively standard on most microcomputers — the game or paddle port. The game port allows the actual creation of simple and inexpensive computer-interfaced apparatus, such as temperature probes and photocells (McInerney and Williams, 1983). Inexpensive devices taking advantage of this feature are already on the market. I conducted a whole human physiology lab using one of these paddle port interfaces, which allowed students to use the microcomputer to perform experiments involving response time, biofeedback, respiration rate, and heart rate; the microcomputer displayed and stored graphic information. Experiments using the apparatus as a lie detector are also possible, since several of its measuring capabilities can be used at the same time.

Computation and Data Analysis. There is abundant software that will allow science students to use the microcomputer for computation and data analysis. This software includes electronic spreadsheets, graphic displays, and statistical packages. There are a number of electronic spreadsheet programs. Basically, these programs provide a huge accounting sheet on which data can be entered and then manipulated by inherent and by user-developed formulas. A key feature of such programs is that, when one value is changed they automatically recalculate all the other values. Programs that display data in graphic form or that do statistical analysis of data are often integrated into spreadsheet programs. Of course, there are also statistical packages and graphic presentation programs that allow direct input of data for manipulation. My students use a graph-making program to make graphs of laboratory report data. They still have to make decisions concerning the type of graph, the axis, and the scales, but they can produce very professional-looking results with relative ease.

Data Management. Data base management programs are available for most microcomputers. These programs have many uses in the science laboratory. Basically, a data base management program is an electronic filing and retrieval system. Any laboratory could use one of these programs as an inventory device. After a quick introduction, my students or lab assistants can easily find out where any piece of equipment belongs. Data management programs have many other uses. Cataloguing and keying specimens or organizing and searching reprint files are just two of the possibilities.

Word Processing. Microcomputer-based word processing has had an incredible impact on the quality of written assignments in my biology classes. I have encouraged my students to make use of the word processing capabilities on campus, and the suggestion seems to be well taken as judged by the number of perfectly typed papers that I receive. Any science course that requires students to write lab reports or term papers would benefit greatly by the introduction of word processing. Papers done on a word processing system tend to have fewer spelling errors and to be more legible, and students are more apt to edit and revise their work. The final result is a professional presentation, of which the student is very proud (Levin and Doyle, 1983).

Equipment and Software Considerations

There are many microcomputer systems and much software appropriate for educational use on the market. Based on my experience in using microcomputers in the sciences, I have seven recommendations: First, since a science course is not necessarily a computer course, the less computer manipulation the better. In other words, a system that uses a disk drive for storage and that boots automatically is preferable. However, this may cease to be a concern as increasing numbers of students achieve computer literacy.

Second, simulations often use color for their presentation;

therefore, a microcomputer with color capabilities is important. In contrast, a monochrome monitor is best for word processing and spreadsheet applications.

Third, to produce hard (printed) copies of graphs, a printer with graphic capabilities is necessary.

Fourth, in order to use the microcomputer in the lecture setting, it must be able to be seen by a large group. Large professional television monitors are best for this purpose because of their high resolution.

Fifth, a real advantage of microcomputer systems over larger computer systems is their independence. It seems a shame to negate this feature by fastening a micro down in a permanent location. Microcomputers on movable stands can easily be placed where they are needed, whether it is in the lecture hall or in the lab.

Sixth, software is the basis of any computer usage. Before purchasing any system, make sure that science software is available for it. When shopping for software, read the reviews, not just the catalogue ads.

Seventh, software is available from numerous sources. Thus, the science instructor does not have to be able to program. However, a knowledge of programming in a simple language such as BASIC can be quite valuable. Being able to program allows the instructor to customize software for special uses.

Future Considerations

Computers have long been a fixture in the sciences. Microcomputers allow the science educator to use computing technology in the classroom. Microcomputer technology will allow educators to increase their pedagogic effectiveness by increasing the possibilities for individualization and by opening up new areas to student-centered inquiry. Microcomputers have not only made computing power available in the classroom but have also made it the standard in industry and science. By exposing our students to computer technology in the community college, we are preparing them to enter the vocational arena.

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Microcomputers can be used in a variety of roles to reintroduce participation and exploration to undergraduate behavioral sciences.

Behavioral Science Applications of Microcomputers

Clifford Roger Dillmann

Behavioral science faculty are torn between teaching old and new findings and the realization that the findings are more fragile than the methodology behind them. Instructors hope that the behavioral sciences will help students to think about and solve problems in their family, business, and world, but the courses that they teach become filled with history and definitions. Active student participation is further reduced as community and four-year colleges alike assign to the social sciences large classes with their correlates—lectures and multiple-choice tests. Students and instructors become used to, if not comfortable with, a passive view of the behavioral sciences.

This chapter proposes that microcomputers can be used in a variety of roles to reintroduce participation and exploration to undergraduate behavioral sciences. As a tutor, the computer can provide individual instruction. As a tool, it can help students to write, calculate, and evaluate. As an environment, it permits observation and experimentation with a minimal commitment of time and money (Taylor, 1980). This chapter surveys the possibilities for using microcomputers in the behavioral sciences. This approach should provide those interested in using computers with some ideas and alert them to

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the small but exciting literature now available. Uses are classified in three ways: those unique to students, those unique to instructors, and those shared by both. This chapter also examines implementation, and it concludes by considering alternative futures.

Uses Unique to Students

Computer-Assisted Instruction. In its classic form, computer-assisted instruction (CAI) parallels programmed textbooks by following displays of written or graphic material with questions or exercises that test understanding. Like programmed text, it can, when well written, assure competence before allowing students to continue. Graphics, often with color, are possible on most microcomputer systems; plots, charts, and pictures approach newspaper resolution. Unfortunately, good CAI programs demand the same attention to detail as their book predecessors and considerable programming skill if they are to accept correct answers in a variety of forms, if they are to branch to appropriate material in response to students' answers, and if they are to use still or animated graphics and sound effectively. Few of the programs now available attract either student or faculty attention at the college level.

More positive examples outside the behavioral sciences illustrate the potential of CAI. One company uses computerized presentation for in-service training of repair technicians as new products are released. Physicians can get continuing education credits by documenting their completion of CAI units. In both cases, the ability of the computer program to prevent completion until the material is learned permits operation without supervision and testing.

The relative dearth of CAI software may reflect the inexperience of educational programmers and the difficulty of attracting the financial support necessary to develop quality materials. At Harrisburg Area Community College (HACC), we have yet to locate any software to implement CAI in the behavioral sciences, and we have not had the resources needed to produce our own material. Reading the literature, we find that our inactivity in this area parallels that of other colleges and secondary schools.

Simulation. When the power of the computer is used to model or simulate the real world, the student is directly involved. Depending on the form of the program, the student may run different alternatives and gather experimental data, play the game using his or her knowledge of theory to win, or observe processes that would otherwise be presented only in text. At HACC, a student-written emulation of a maze demonstrated repetitive training trials; the imaginary rat's learning speed and errors depend on reward. In five minutes, the computer rat provides sufficient data to illustrate trial-and-error learning, data plotting, and elementary statistics, thereby replacing several days of data collection.

Several commercial products can be mentioned in this regard. Eliza, an implementation for microcomputers of the classic computer therapist program, can be used by individual students or as a classroom demonstration to simulate Rogerian therapy, demonstrate artificial intelligence, and introduce students to the potential and limits of computer therapy (Weizenbaum, 1976). Limits: A World Growth Simulation presents a shortened version of the world dynamics model described by Meadows and others (1972). Students can implement changes to stabilize population or conserve resources and see outcomes plotted. While the program parallels the book in illustrating the ineffectiveness of simple changes, its impact is stronger, since the student tries the alternatives directly. Another popular program, Three Mile Island, is of particular interest to Harrisburg residents. It can be defended as an effective graphic demonstration of nuclear reactor principles, but it goes beyond that—as the operator you must accept the risks of ignoring government orders and maintenance schedules to maximize profit.

The three simulations just described establish how the method presented is to be used and confirm its demands for participation and analysis. Of the three commercial products just described, only Limits was written for education, and even it was adapted from a research publication. As with CAI, only when software developers and publishers spend the same resources for the education market that they now spend for the game market will the potential of simulation be realized. Ahl (1983) and Bennett (1976) describe programs that can be implemented on any microcomputer. Dethlefsen and Moody (1982) and Schrodt (1982) provide listings for programs that can be used to study neighborhood integration and escalation in the arms race. Olinick (1978) provides an overview of modeling and simulation.

Uses Unique to Instructors

Test Preparation. Textbook publishers have begun to make their test banks available on disk for popular microcomputers. While the programs as written cannot easily be edited, most permit a variety of question types, most permit instructors to write their own questions, and most print both a finished test and an answer key. Since the final printout can be to a ditto master, an entire test can be assembled and duplicated in less than an hour.

Test Grading. Many companies now make optical readers that work with 8½ × 11 inch or IBM card size answer sheets. When linked to a microcomputer, an optical reader not only grades examinations quickly and accurately, but it can also provide statistics and individual reports.

Gradebook. Gradebook programs deserve consideration either when regular individualized reports are needed or when many items must be weighted for the final grade. Instructors who use only a few grades per student, who base the course grade on a simple sum, or who make a report only at the end of the term, may find that the chores of computer access and data entry are more onerous than the gain.

Uses Shared by Students and Instructors

Word Processing. Students and faculty alike can use microcomputers for word processing. Most word processing programs can be learned without formal instruction and approach the power of dedicated word processing systems. Students can write and redraft papers as often as necessary without having to spend time or money retyping. When the paper can be submitted on disk or via central storage, the instructor can make comments or indicate the need for revision in the text itself. For instructors, word processing places all handouts and written materials for a course on a disk. Evolutionary changes can be made without the need for retyping. Most computer printers can be set to emphasize or double strike, and in those modes they yield excellent ditto masters. The word processors can also be used to store the repetitious forms, annual reports, and other submissions required by administrators.

Data Plotting. A computer can be programmed to generate standard graphs either on the screen or as hard copy. Even a computer without graphics can plot on paper by using letters to represent data points. Appleplot is used in our psychology laboratory for plotting experimental data. Students in general psychology can now make a variety of data plots, since, once they learn to use the program, it takes little more time to create individual plots than it does to type in the numbers. Students' enthusiasm for this approach can be measured by the fact that they frequently make multiple copies to show to friends and parents. Appleplot is easy to use, but it is limited to simple plotting. A more complex alternative, Graphpak, can input data from the keyboard or laboratory instrument, perform transformations (linear, nonlinear, derivative, integral, averaging, and so forth), fit the data to a variety of equations, and plot using most common graph forms. Its flexibility and its ability to handle up to 4,000 points, taken 100 at a time, permit it to be used for formal research data. Korites (1982) provides background and programs for those interested in designing their own data plotting programs.

Statistics. Statistics packages can be purchased from commercial sources or composed from programs described in books (Cooke and others, 1982) or available from user groups. Students can now use *T* tests, *F* tests, correlation, chi-square, and a variety of descriptive statistics as soon as they can be taught how to apply them. By obviating the need for calculations, such software allows students to think of description, inference, and proof as possibilities for their own experimental data. Too often students never use statistics as a research tool because they become overwhelmed with the laborious calculations that must be undertaken when using a calculator.

Computerized Conferencing. Computerized conferencing enables two or more individuals to interact via microcomputers and modems. In this context, the computer can serve as communication tool, data base, word processor, and medium for conferencing. Preliminary data indicate that it is both time- and cost-effective for this purpose (Hiltz and Turoff, 1978; Kerr and Hiltz, 1982). Implementation at the community college has potential for involving students and faculty in dialogue at the time and place they choose. Another possibility is interactions with other colleges or with persons from business, politics, or communities of interest.

Information Resources. DIALOG, CompuServe, The Source, and other on line data bases provide immediate access to abstracts and references in virtually every field. These information resources can teach research skills while providing immediate access to current information. Development or purchase of data bases in specialized areas for student use is a less costly alternative.

Computerized Experiments. While simulations give students a chance to use research techniques, they do not give them the experience or satisfaction of working with real subjects. To provide such experience, the computer can be configured as a piece of apparatus. While the computer may be more expensive than any one piece of the apparatus emulated, it is cost-effective when it substitutes for many such pieces.

Software written for the HACC psychology laboratory includes a memory drum with lists controlled by the user and digital timing, a short-term memory span experiment using random digits, and an experiment using afterimages. The memory drum program asks the experimenter to make a list, make a new list, and select presentation times. The experimenter is left to instruct the subject and to gather the data. The program removes the need for typing the lists. The equivalent mechanical apparatus would cost between $200 and $700.

At HACC, we used a published program to construct a human maze program, which can be used quantitatively to study the learning process. Perhaps its greatest contribution is in its use of graphics to give students a sense of being in a maze. Once lost in a trivial four-by-four maze, students no longer laugh at their rats!

Surveys. The microcomputer can assume two roles in survey research. In analysis, it provides statistical tools that are sufficiently easy to use that beginning students can look at their data effectively. Data can even be input without keyboarding if a suitable optical character reader is available. The microcomputer can also be used as the survey instrument (Heise, 1982). When the microcomputer is placed in a hall, cafeteria, or shopping mall, passersby can stop and answer the questions that it flashes on the screen. For multiple-choice questions, the computer can be enclosed; respondents can use joysticks, buttons, or a light pen to indicate their answers.

Collection of Laboratory Data. Robert Tinker at Technical Education Research Centers (TERC) (8 Eliot Street, Cambridge, Massachusetts 02138) provides information and inspiration through workshops and *Hands On*, a newsletter. His program Experiments in Human Physiology combines software and hardware to record heart beat, respiratory rate, and skin temperature. Students who have no prior laboratory experience can perform experiments and print out data for later analysis and graphing. While the psychology laboratory has long supported physiological experimentation with a datagraph, the time needed to learn how to use it effectively has ruled out all but the most committed students. The fact that a single datagraph of less than research quality can cost more than three to ten complete microcomputer systems is critical when cost is a factor.

During my sabbatical, I developed for the Museum of Scientific Discovery in Harrisburg, Pennsylvania, an exhibit entitled "Skin Talk" using a low-cost interface for the galvanic skin response (a measure of stress). It uses an optical isolator to protect the subject and equipment. Biofeedback instruments, datagraphs, and other instruments can be safely connected through the game paddle inputs found on most low-cost microcomputers. The exhibit demonstrates that use of a computer for data recording and graphing permits naive subjects to record, graph, and experiment with their galvanic skin response. The program is operated by two pushbuttons and an adjustment control.

Implementation

Activity can be initiated in most of the areas just reviewed on any computer for which the appropriate software is commercially available. We have found that the programs and peripherals available for the Apple II and IIe greatly ease implementation. If funds are short, similar results can be achieved with the Atari 800 or 800XL, the Commodore 64, and similar computers.

Two frustrations often follow initial success in using purchased programs. First, at the college level, particularly in the behavioral sciences, thinking quickly outstrips the available hardware and software. The behavioral sciences will not soon become a large enough market to attract well-funded development efforts. Second, budgets will rarely permit unlimited acquisition, and less costly hardware and programs constructed from listings in books and magazines will have to substitute. Bob Tinker at TERC and others have shown that significant activity can be generated with low-cost computers and virtually no software support if faculty and students are willing to invest their time in the effort.

At HACC, several routes have been taken to facilitate development of software for college use. Faculty, with and without college support, have learned programming and created useful materials, college workshops have been held, staff programmers have been hired when funds were available, and student workers (often with programming skills well beyond those of their instructors) have developed original programs and adapted programs from other sources. Most recently, the college has created a staff position to assist those working in this area. This position complements the technical support furnished for several years by our audiovisual group. Our experience both with students and faculty is that one of the best learning modes for this new technology is personal exploration backed by access to competent advisers.

Do users need to learn to program? The question has been extensively debated. While games and business software have evolved to a point where users do not need to be directly involved with the computer, materials in our field have not. Many of the best of our acquired materials have required modification. Most programs require students to initialize their disks, that is, to program them for use. Many programs require modification or the addition of short utility programs so that files can be stored or the printer can be used. Even copying a program from a book or magazine requires some programming knowledge to adapt the material to a particular use or computer. In short, some programming knowledge must be available among faculty, students, or student workers if the full potential of this new medium is to be exploited. The learning process is not as difficult as often imagined. The behavioral sciences share with the liberal arts competence in language and logic, and the skills required for analysis in behavioral sciences are similar to those required for designing a program.

Alternative Futures

This chapter summarizes a broad range of possibilities. At one extreme, word processing and statistics programs can be implemented effectively by purchasing appropriate computers and software. At the other extreme, the use of computers for simulation, communication, and data gathering is experimental, with both methods and proofs of effectiveness awaiting further efforts. Microcomputers offer the possibility of bringing to community colleges facilities that have long been available only to well-funded four-year colleges and graduate schools. If our students can use this new tool to participate actively in the behavioral sciences, they may come to see our field as we learned it, they may become more competitive when they transfer to colleges where skills in the use of a computer are expected, and they may become comfortable in using computers to reach real goals in a way not easily achieved by taking a course in computer programming or computer literacy.

We have been challenged by *Educating Americans for the 21st Century* (National Science Board Commission on Precollege Education in Mathematics, Science, and Technology, 1983) to match efforts to improve education in science, mathematics, and technology with improvements in the liberal arts. One of the commission's many recommendations, and one of the many routes to such improvement, lies in implementation of the computer in the behavioral sciences.

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Graphpak. Includes Vidichart, Curve Fitter, and Scientific Plotter. Interactive Microware, Inc., P.O. Box 771, State College, Pennsylvania 16801.
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Teachers must face the challenge of computerization, especially as computers come down in cost, students become increasingly computer-literate, and school budgets begin to reflect the cost of a new technology.

The Microcomputer in Business Education

David R. McKay

Business education seems to face an uncertain future. Computerization looms on the horizon as a challenge for all business education teachers, whether they want to confront them or not. Many teachers involved in business education for twenty-five or thirty years are only holding on until retirement and wish to avoid learning about new technology. Others feel that high technology is applicable only to industry.

Secretarial education must take an entirely different approach from that traditionally used. The microcomputer and silicon chip technology certainly must have an impact on the business education classroom. As computers become cheaper and as computer literacy rises among incoming postsecondary students, computerization will become more attractive to school administrators; therefore, budgets will reflect the cost of this new technology. Ready or not, teachers will face the challenge of the electronic age.

Microcomputer or Word Processor?

First, we need to distinguish between the microcomputer and the stand-alone word processor. A stand-alone word processor is a self-contained unit not connected to any other equipment or to a mainframe computer. It is preprogrammed with all the needed commands, and it

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functions solely as a word processor. In contrast, a microcomputer is a small desktop computer, to which appropriate components, such as a keyboard, a video monitor, a disk drive, and a printer are added. It can function as a word processor if the appropriate software is used with it or as a powerful calculator with accounting as well as other business applications.

For several reasons, this chapter advocates using the microcomputer to teach word processing applications. First, the computer can be used to teach all business subjects, and it is therefore very flexible. Second, a microcomputer costs just a fraction of a powerful standalone word processor. Third, a postsecondary program should aim to teach word processing concepts, not word processing equipment.

The Learning Center Concept

In order to move into computerized instruction, one must consider the establishment of learning centers. Learning centers are organized in an open entry–open exit concept that lends itself to the flexibility of the microcomputer and to the philosophy of the community college, where the learning center seems to function best.

Design. The center's design must be multifunctional, multilevel (that is, several classes must be able to take place in the same classroom at the same time), and self-instructional. Microcomputers will replace typewriters as a teaching tool. Therefore, business educators need to develop a different approach to the teaching of typewriting skills. In the past, they required students to sit down at a typewriter and practice typing letters, memos, outlines, manuscripts, tabulations, and forms, and the students ended up with a typed hard copy document that was submitted for evaluation. Now, educators need to emphasize the way in which students enter and manipulate words, sentences, and paragraphs to arrive at the final document. There should be less emphasis on speed and more emphasis on accuracy and proofreading. Making corrections on the screen, moving words and paragraphs around to clarify content and increase impact on readers have become more important. Originators feel free to rewrite when the effort required to produce the actual document is less strenuous.

Redefined Roles. In order for business educators to be successful in the learning center environment, they have to understand that a new role has emerged for the professional educator. Teachers in the new centers can no longer function in the role required in the traditional, teacher-dominated classroom. They now become creators of materials and managers of a self-instructional learning system that makes students increasingly responsible for their own learning. A professional educator directs the curriculum, provides the materials, and evaluates the progress. For such a system to be successful, faculty must realize that students can learn even when the teacher is not physically present and that a trained paraprofessional can help students with the routine problems frequently encountered in a learning center.

Cost-Effectiveness. In order to be cost-efficient as well as flexible, the learning center should be designed so that one disk drive and one printer can serve several microcomputers. The resulting network system will be a new concept for some teachers. However, the arrangement is not only cost-effective, but it also allows several courses to be taught simultaneously. Thus, the concept is multifunctional. In this, it differs considerably from the traditional business education delivery system. The term *multilevel* indicates that the system has been designed so that two or three levels of a course, such as typewriting or word processing, can be taught at the same microcomputer learning center. There are two essential ingredients for the success of such a delivery system: the development of self-instructional methods and an understanding of the importance of teachers' new role as managers of a networked business educational system.

Vocabulary. Teachers will need to learn a whole new vocabulary to go along with the new equipment. Simply stated, teachers must become computer-literate.

Politics. Learning to cope with the politics of learning center control may be new to business education teachers. Long discussions will ensue over the organization of the center. Is it to be centralized or departmentalized? The science people believe that their needs are far more important than the needs of others. According to math people, computers were made for mathematical applications, so the math department will want control. However, business departments have high enrollments and can easily demonstrate a high demand for computer word processing applications. In short, if business teachers do not become computer-literate, they may find other departments eager to set up and operate the computer centers. If the politics dictate a centralized center, then who is better suited to run it than the business department? Business teachers are experts in keyboarding and data entry. They have math skills and communication skills. After all, a microcomputer is a combination of a typewriter and a calculating machine, which business educators have operated for the past sixty-five years.

Theory into Practice

At Monroe County Community College, we have experienced all the problems described in this chapter. It appears that our college will establish microcomputer centers in several departments. The basic reason for this decision is that micro applications are vastly different in each area. Dedicated centers free of interdepartmental politics, staffed with trained paraprofessionals, and furnished with equipment and software best suited to teach the specific applications will cause fewer problems in the long run. Moving to a microcomputer delivery system and implementing the new technology alone will cause faculty and administration many problems. However, I hasten to add, not one of these problems is insurmountable.

Monroe County Community College serves about 3,000 students at two centers. The main campus in Monroe is located between Detroit, Michigan, and Toledo, Ohio. The county has a population of 127,000, and it is mostly rural. It is influenced by economic conditions in Detroit and Toledo. The recent economic slump caused enrollments to rise in all areas of the college, especially in such programs as word processing and data processing. Students wanted the training, and, in order to provide them with opportunities similar to those available in more densely populated areas, we felt that we had to enter the micro age.

Last year, we equipped three self-instructional, multifunctional computer centers with Commodore 8032 CBM computers. The center at our South Campus opened with ten stations. Eight stations are configured into two networks, in which one Commodore 8050 dual disk drive and one Commodore tractor-feed printer serve four computers. The computers are equipped with WordPro 4-Plus, a hard disk word processing package. This allows us to teach word processing, keyboarding, and the BASIC language portion of our Introduction to Data Processing courses at a single center. Thus, the center is truly multifunctional. Stations were designed to be mobile so that we could transport them to another room for use by the continuing education department. The ten stations cost about $2,057 per station, exclusive of the cost of furniture.

At the main campus, we equipped a second center to be used to teach BASIC programming and keyboarding. The center was funded with economic development money provided by the state of Michigan in order not only to teach regular college career programs but also to enable the Continuing Education Community Services Division to teach small business and farm applications of microcomputers. The second center was not networked, because some of the software used requires dedicated dual disk drives; the hardware cost $400 more per work station than it did at the South Center.

The third center that we established was an addition to an existing word processing center. We already had four stand-alone word processors, but the demand for training was so great that we felt we needed to add additional equipment. It was not possible to expend another $30,000 to $40,000 for another four stand-alone word processors, because the money was not in the budget. We reaffirmed that our objectives were to teach concepts and that we could teach concepts just as well on microcomputers, so we purchased four microcomputers, and equipped them with the same word processing software that we used at our South Center, and we were in business for a total of about $14,600, including hardware, software, and furniture. Our success is a fairly strong argument against stand-alone word processors. I do not want to leave the impression that establishing the three centers was an easy task. We had our problems and encountered moments of frustration, and even now problems arise, but every problem can be solved.

What Lies Ahead?

We now stand at a crossroads trying to decide what direction to take. Our typewriters need to be replaced, our secretarial curriculum has been patched over the past seventeen years, and our catalogue is up for revision. The direction that we should take has been the object of much discussion. The discussion has led us to conclude that we need to revise the entire secretarial curriculum so that it centers on the microcomputers. This is certainly a radical move, yet we feel that the emerging electronic office will have a significant impact on the curricula of secretarial programs and on business education in general. Since the instructors in the secretarial department are committed to the self-instructional approach, virtually all instructional materials must be rewritten and recreated to accommodate the microcomputer. This is no small task.

Beginning typewriting will remain unchanged. However, we propose to use computers to instruct students in intermediate and advanced typewriting. The instructional materials used in word processing, along with other existing media, will be adapted for the intermediate and advanced typewriting courses. We plan to combine common concepts from Beginning Word Processing with Intermediate and Advanced Typing, so that the courses can be taught in a single center. Our advanced word processing courses will remain intact for students who want to further specialize in concepts beyond basic machine operation skills.

The microcomputer is increasingly being used for typing instruction in junior and senior high schools around the country. According to Helen Barron, author of the Type Right software that we are currently using in our keyboarding course, approximately 2,500 secondary and postsecondary schools in twenty-five states have incorporated a keyboarding course into their curricula.

Shorthand will remain in the curriculum. However, we will recommend changing the method of teaching: Audio-tutorial methods will enable it to become a self-instructional course. This move will make the course available to students year round. They will enter at a comfortable level and progress from that level through the course. Office Procedures and Secretarial Procedures courses will be revised to include training for the latest concepts of the electronic office. The revision will be total.

To accomplish all this, it will be necessary to reduce the teaching load of secretarial faculty for a better part of the year and to employ them during the summer. We have already started this process, and their current teaching load is being picked up by part-time instructors. We hope now that the administration will find the capital needed to complete our conversion from the old to the new technology. If our estimates are correct, we can expect to spend an additional $28,000 to $30,000 for twenty more stations. To accomplish this expansion will require creative design. We will have to use some current equipment, and networking arrangements will be required to tie everything together. By January 1985, we should be teaching the new technology.

Conclusion

I believe that business educators must move to networked computer learning centers. They must become computer-literate. They must be aware of the problems that they will encounter in regard to software, hardware, courseware, and costs, and they must be prepared to deal with the politics of microcomputer acquisition and use. They must consider that a self-instructional delivery system is a dynamic instructional method, especially at the postsecondary level. They must take the initiative to move their curricula in the direction of microcomputers and reorient their courses to reflect the new technologies. Finally, they must consider the cost and flexibility of networking.

Concern over American education is growing, as Boyer (1983) points out, and the National Commission on Excellence in Education, a panel named by the U.S. Secretary of Education, has called for "The New Basics." The commission has recommended four years of English, three years of mathematics, three years of science, three years of social studies, and one-half year of computer science as a common curriculum for all high school graduates (National Commission on Excellence in Education, 1983). Moreover, the commission recommends that the computer science taught in high schools should equip graduates to understand the computer as an information, computation, and communication device; to use the computer in the study of other basics and for personal and work-related purposes; and to understand the world of computers, electronics, and related technologies. Clearly, these two recent reports confirm my statement that computerization looms on the horizon as a challenge for all business education teachers.

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English faculties are discovering that the computer can be a valuable new medium for student writers. Word processing and related programs are bringing innovative strategies to composition classrooms and writing centers.

Computer-Assisted Writing

Robert L. Levin

One of the most auspicious educational applications of microcomputers is occurring in the discipline of writing. In an ever-increasing number of colleges around the country, teachers of writing are discovering the advantages of computer-assisted writing (CAW). These teachers are finding ways to employ word processing as a writer's tool and to use dictionary and editorial programs in conjunction with the word processing function. The implications for future writers seem vast. The purpose of this chapter is to explore some of these implications and to suggest some useful steps in the development of a CAW program.

Most of the innovation inspired by the advent of microcomputers in the discipline of writing has happened through word processing. The mood in the word processing writing lab usually resembles that of a plugged-in beehive. The hum is a new admixture of brains whirring, writers uttering faintly audible hmms as they ponder the obstacle posed by a new paragraph or a program command, and the buzz of the printer, which sounds like R2D2 with laryngitis. A pioneer mentality exists. The excitement of breaking new ground is tempered by the fear of unforeseen hazards around the next bend. Commiserating with each other urgently, faculty and students easily engage in small group exchanges: "Did you see what that printer did to my text?" "Colleen, what does *unerase* mean?" "Hey, try running your paper by that dictionary program.

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It tells how many times you used each word. It must have some kind of significance." "Finally, I'm done!"

The introduction of microcomputers into writing classrooms and labs has generated excitement and offered a new tool for the difficult and challenging task of writing instruction. In general, faculty and students are eager to try the machine of the new revolution. Sometimes, they seem a bit nervous, but they are also truly eager.

Historical Accidents

The idea of using word processing as a writer's medium came inadvertently to some faculties. At North Country Community College in New York state, for example, the business, data processing, and secretarial programs used the microcomputer lab to teach computer literacy and word processing to students in their courses. It must have occurred to some of these business, data processing, and secretarial students to use the word processing program instead of a typewriter to produce a paper for an English assignment. We English faculty began to receive essays printed on a dot matrix printer. Some of us thought that the papers showed improvements that might result from the medium.

Our curiosity aroused, we began to experiment by sending individual students to the microcomputer. Initially, they were students identified as weak writers either by prior experience or by learning disability. Later, however, the student users of CAW came to include at least as many accomplished, successful writers as they did weak ones. Eventually, the CAW projects were formalized: Faculty shared ideas about values and problems, administrators found funding for additional machines, and we initiated checkoff sessions for freshman composition classes.

Similar programs began to evolve at other colleges and universities. Participating faculty spread the word at professional meetings and in the journals. Increasingly, the conferences of English and writing faculty associations included sessions on the use of microcomputers to teach writing skills. Professional acceptance of CAW grew. Zinsser (1983) signaled the legitimacy of the CAW movement with a book that chronicled his reluctant but finally enthusiastic conversion. Also, a forthcoming whole issue of the *Writing Program Administrators Journal* will be devoted to essays on word processing as a writer's medium. At this point, only a relative handful of colleges has made a commitment to the CAW experiment, but the number is growing.

The Benefits of Word Processing as a Writer's Medium

What advantages are to be gained by adopting the new medium? How can writers benefit from a college CAW program? In this section, I report some of the positive results observed by college faculties.

Changing the Instructional Context. By the time students leave high school, they have written and submitted hundreds of handwritten compositions. It is understandable that these students may have become insensitive to the implications of format. The microprocessor offers the possibility that writing can become a new kind of activity, one that encourages the writer to notice how format can influence the effectiveness of communications.

Also, the machine itself is a strong attraction. Students are curious about computers. Even the tentative or fearful seem to have a secret wish to play with the technology of the future. Faculty have noticed the animation and anticipation that students demonstrate when computer sessions are announced for the first time. Some faculty speculate that either the computer's similarity to television is inviting or that the sense of technological sophistication makes the microcomputer fashionable. What is important, however, is the renewal of optimism and energy that many students have for the composition process.

Composition and Revision. The commands built into word processing software make revision a dynamic part of the composition process. Once writers learn to delete, correct, add, and transpose, revision can occur both more readily and more often.

In general, we have observed an increase in substantive revision as a result of CAW. However, two qualifications should be noted. First, to the extent that the writer needs to think about how to command the machine, the writer's composition process will be interrupted. Like the traditionalist who sits down to write with a dozen sharpened pencils or a handful of ballpoint pens, the microcomputer writer does not want to be bothered by the medium. The writer cannot interrupt the train of thought to ask, "Now, how do I indent?" or "How do I change the position of this phrase?" It is only when the commands fundamental to a given word processing program become second nature that the writing process can flow as spontaneously as it should.

Second, as a result of the need to internalize the word processing program, most fairly new CAW writers do their word processing drafts and revisions only after they have generated an organized text by other means. That is, a writer will draft a composition by hand, then put the rough draft into the microcomputer. There is great value in this step; now, the word processing program can be used to manipulate text. Manipulation is easy, and multiple revisions are encouraged.

Later, when writers become experienced in the program's commands, the composition process becomes as easy and open as hand- or typewriting ever was, and as an added feature, the composition can be revised any number of times without having to retype the whole paper.

Storing and Printing Text. Using the machine's ability to save text, the writer can file a copy of each draft on a floppy disk, in much the same way that sound can be stored on magnetic tape. This storage ability permits writers to return to the writing process, to store text for later reference, and to build easily retrievable files for research purposes, glossaries, bibliographies, and footnotes.

The printer connected to the microcomputer is an important part of the writing process, both for producing the final draft and for providing students with legible copies that they can use for editing and proofreading purposes. Proofreading has become an important step for many CAW writers. Unable to perceive the flow of the whole composition, since only a portion of it is visible on the monitor screen at any one time, students will print a copy of the draft, at the same time saving it on their disk. Taking this copy to a nearby desk for a careful editorial reading, the writer will later return to the microcomputer to make the changes noted on the printed copy. The dot matrix printers now available make copies that are dark and clear enough to satisfy most readers. Of course, letter-quality printers are also compatible with the microcomputer.

Students and instructors have learned to appreciate the increased legibility of computer-printed papers. Students submit papers that more closely approximate professionally acceptable form, and the papers are free of the idiosyncrasies of handwriting. It may be that for some students anticipation and examination of the printed copy inspire greater care with the quality of the prose itself. This result is akin to the result of a practice that many English teachers have followed: taking handwritten drafts and having them typed. When the writers of the drafts see their work in typed form, they notice errors that had escaped their attention in the handwritten versions.

Alternatives for Learning-Disabled Students. Students with a variety of learning obstacles have used computers to improve their writing. A range of problems related to hand–eye–mind coordination, dyslexia, and hyperactivity appears to have been managed successfully through the use of word processing programs. Sentence combining and other fundamental sentence and phrasing work in the composing process can be made into worthwhile game sessions, which can add skills that are useful in improving prose writing.

Building the Program: Faculty and Administrative Involvement

One traditional objection to the educational deployment of microcomputers is that the machine will replace teachers. Practice has indicated that this is not the case. In fact, CAW appears to have created more work for faculty, not less. Some colleges have created new writing courses in which word processing is a component. Some English instructors gain release time or sabbaticals to study programs and programming related to writing skills. The net result of sucessful CAW efforts has been to illuminate the value of the English faculty, to point out their ability to stay current, and to increase the credibility and attractiveness of writing instruction.

In order to develop a successful CAW program, widespread faculty involvement is required. Five steps have proved to be the stepping stones to CAW projects in more than one college. First, identify program leadership. One or more faculty or administrator need to emerge as ballcarriers who take the program past obstacles and through channels to implementation. These leaders usually need to be energetic believers in CAW. Their academic practice and reputation must be sound, and their ability to communicate diplomatically must be demonstrable.

Second, gain administrative support. A CAW program needs money and space. These commodities always require administrative blessing, if not aggressive support. Some deans and presidents are already convinced that computers are here to stay in education. Some are not. Some are, but they fail to see why English teachers need microcomputers (the "logical" requests come from computer science, math, and science faculties). A common administrative perception is that faculty want toys to play with or that faculty want the superficial status symbol of a few computers at their disposal.

Third, CAW program leaders can work against these ways of thinking by demonstrating the viability of a CAW project. The available supportive evidence includes the increasing number of academic articles and books on CAW; the increasing number of writing curricula and programs that offer versions of CAW (Seminole Community College has a budding CAW program that several groups from area colleges and universities have visited); the support for CAW instruction from potential employers (the kind of computer literacy produced by CAW courses looks good on students' resumes); and faculty testimony (the administration will feel more pressure to devote resources to CAW as more faculty become convinced of its value).

Fourth, one artfully placed computer can do wonders in attracting faculty attention and arousing curiosity. Setting up a microcomputer station in a faculty work space or in a writing center—a place where writing faculty are likely to go—usually is enough to start something that gathers and grows. Someone on the faculty will know enough to start putting his or her course outlines on the word processor, and someone else will be looking over the writer's shoulder. Soon, demand for time on the machine becomes intense. A staff person who can act as a guide and provide needed assistance is an absolute necessity. This person may be a faculty member or a paraprofessional, but he or she needs to be available to troubleshoot, to console beginners for their small frustrations, and to survey and select useful software. Faculty fear and hesitation can be vastly reduced if such a person is around to hold beginners' hands.

Fifth, CAW leaders can build the movement by organizing inservice workshops for faculty. A college with a computer science or data processing faculty and some microcomputers can tap these resources to establish orientation workshops. Colleges without such programs and equipment may find that a local computer distributor is willing to help. The most fundamental principles and uses of microcomputers can be demonstrated at workshop sessions. These demonstrations can dispel some of the fear and reluctance that faculty often feel toward the machines. Microcomputers need to be available to faculty after such workshops. Instructors whose appetite is whetted by an orientation session will feel frustrated if no machine can be found for follow-up.

Software

Most word processing programs are sufficiently complex to daunt the courage and determination of many faculty. For these complex programs (which include Apple Writer II and WordStar), a program assistant or troubleshooter is a necessity. This person, who can be a computer science student or a paraprofessional who feels comfortable with English instructors, can help faculty learners to move past the small frustrations that a CAW beginner always encounters.

Relatively simple word processing software can do wonders for the confidence of beginners. Some CAW programs have had good luck with Bank Street Writer, a simple word processing program originally designed for young writers. The ease with which one can enter this program and begin to write is encouraging for most first-time microcomputer users.

Tutorial programs can help novices to learn the operations and capabilities of a particular microcomputer. All the major brands—Apple, IBM, Commodore, Radio Shack TRS, and others—have tutorial programs for beginners. Most of these programs are friendly and accessible and frustration is kept to a minimum. Cdex tutorials have also proved useful; they exist for several kinds of microcomputers.

Microcomputers in Writing Centers

CAW projects can appropriately be housed in a writing center. In fact, the introduction of word processing instruction into a writing center will likely alter the character of that center in surprisingly helpful ways. To the extent that the writing center is traditionally and predominantly used by weaker English students, it has the character of a remedial zone. When this character is pronounced, the instruction is stigmatized, and the center has a depressed ambience. Where this pattern prevails, word processing instruction, and the students who aggressively seek it out, can offer relief. Soon after CAW is introduced, a new breed of students—bright, energetic, curious about or already expert on the computer, and eager to share computer stories—begins to appear at the center, which becomes a place not only for remediation but also a place of experimentation and high-level intellectual activity and a think tank for the best and brightest students. The resultant mix of remedial and high-caliber students can be almost utopian in both its social and its academic aspects.

Once the microcomputer stations are in place—two or three will be enough for a modest, beginning CAW effort—a writing center staff member or English faculty member can begin to invite student participation. Announcements, memos, posters, and word-of-mouth can tell faculty and students that writing on the computer is not only possible but available. Such publicity should bring some people to the writing center within a week or two. Workshops for English faculty and for content area faculty involved in writing-across-the-curriculum provide effective introductions.

Next, faculty can be encouraged to send individual students to the writing center for an introduction to CAW. These students may be eligible on the basis of their aptitude, ability, interest, learning disability, or some other suitable pretext. Then, faculty can be invited to schedule whole classes for orientation sessions on the microcomputers. Numbers can be a consideration here: If a class of twenty-five students tries to put hands on two computers, there will be few converts. But, if there are several machines and if the class is divided into groups, fun and profit are possible.

Some faculty will want to assign students a paper to be done on the writing center computers. Now, student writers can be led through the initial steps, then coached and encouraged through the writing process. An assignment obliges students to stay with CAW, even past the first few hurdles that would otherwise send some students back to the typewriter or pen.

Interested faculty can develop new courses, including CAW in a writing course. Seminole Community College has a course called Word Processing and Advanced Writing. At Seminole, students who complete English I may enroll in a course that teaches word processing techniques in the context of composition skills and that allows them to select a track for advanced composition work. These tracks include journalism, creative writing, technical writing, advanced composition, and research writing. The result is that students learn a new writing medium or technology while sharpening and advancing the skills associated with effective written communication.

A large part of the success enjoyed by CAW programs comes from the excitement that surrounds the technology. Students in afternoon composition classes snap awake when told that they will visit the writing center to experiment with writing on computers. Beyond the advantage of the affective momentum, the students' writing seems to improve enough to warrant continuation of the effort. Sufficient numbers of students are revising more frequently and more substantively. Scholars have been provoked to study the effects of CAW on writing quality.

The promise of sympathetically designed composition programs that integrate heuristics into the computer writing process makes the road ahead inviting. Already, dictionary, usage, and other editorial programs are giving students feedback that can make ideas, logic, and style rather than mechanics the writer's primary tasks.

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Can a high-quality two-year program in computer science be supported exclusively by microcomputers? This chapter examines the microcomputer as an alternative to the time-sharing computer.

A Microcomputer-Based Computer Science Program

Larry D. Compeau

Many four-year universities are greatly expanding their computer science programs in order to meet the high demand. Often, that demand outstrips the limited facilities and the short supply of qualified instructors. As a result of this situation, many two-year institutions have begun to offer a degree program in computer science in addition to, or in place of, the traditional two-year program in data processing. Data processing programs are career-oriented. The computer science curriculum is designed for students who plan to transfer to a four-year institution. The two-year programs can relieve some of the pressure on the universities and satisfy the demand for introductory computer courses from the community. This was the case at North Country Community College in Saranac Lake, New York.

North Country Community College (NCCC) had experienced a strong demand from the community for user-oriented courses through the adult education program, and higher-level computer science courses were being requested by full-time students who wanted to major in business and computer science. Additional demand came from graduates of baccalaureate programs who wanted to return for a two-year degree in computer science. How could the college respond to these varied needs?

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A Microcomputer-Based Computer Science Program

It was determined that a two-year program in computer science could satisfy three main objectives. First, it could satisfy the needs both of people in the community who wanted to take courses and were not seeking a degree and of qualified students who were seeking a degree. Second, it could service four-year institutions in the area (three universities in the immediate area have highly respected computer science programs) by relieving the pressure on their first- and second-year courses and by providing them with a steady stream of well-qualified third-year students who would help to sustain their higher-level courses. Third, it could give students who were not qualified for the university programs an opportunity to enter NCCC, build up skills in their deficit areas, transfer into our computer science program, and, if necessary, transfer to a university program.

One of the major obstacles that NCCC—and any small community college considering a curriculum in a computer science—encountered is the high cost of providing such a program. In order to attract students, the program had to be competitive with the first two years of a university baccalaureate program; that is, it had to be comparable in content, quality, and so forth. But it was not clear that such a program necessarily required the support of an expensive time-sharing computer system, which would have been very expensive. One possible solution was to use microcomputers to support the program. Although schools had used both microcomputers and mainframes together, we found no school that had based its program solely on microcomputers. Cost was the main incentive for considering a microcomputer-based computer science curriculum at NCCC, but it was not the only factor that had to be evaluated. Several major questions surfaced as we examined the concept. There were the cost considerations: Given the hardware and software requirements, would microcomputers be cost-effective? There were pedagogical considerations: Are the hardware and software adequate to teach the required concepts? If the computers were capable of supporting the required material, how would the universities react, especially regarding transcript evaluation for transfer? Are there any pedagogical advantages to using microcomputers? What are the disadvantages? Finally, there were practical considerations: Would students have more access to computing facilities or less than they would in a time-sharing environment? Would security pose a problem? Could the facilities be used for applications outside tthe computer science program?

The North Country Community College Experience

Curriculum. Curriculum design is an important factor in the success of a two-year computer science program. In the initial steps of designing the curriculum at NCCC, we contacted other colleges and reviewed their curricula. We also reviewed model curricula promulgated by professional organizations. Many of the four-year institutions had well-designed curricula, parts of which we used in designing our program. Most of the two-year institutions offered traditional data processing programs, which were not applicable.

The objectives of the NCCC program were, first, to prepare students for entry into a four-year computer science program and, second, to provide enough flexibility that students wishing to pursue degrees in related disciplines could do so. The Association for Computing Machinery (ACM) published a model curriculum (Austing and others, 1979), which appeared to be widely accepted and which closely met our needs. That curriculum served as the foundation of our curriculum. Once the curriculum was designed, it was evaluated to determine whether microcomputers could support it (it is important for a curriculum to be designed without regard to the equipment that will be used to implement it).

The curriculum that emerged from the ACM guidelines seemed to meet our particular requirements. The curriculum requires twenty-one credit hours in core courses. At NCCC, CIS 110, Introduction to Computer Systems; CIS 151, Introduction to Problem Solving and Structured Programming; and CIS 152, Advanced Problem Solving and Structural Programming are the first three introductory courses; they parallel the ACM guidelines. Elective courses in systems analysis and design (emphasizing the design of microcomputer and distributed systems), computer architecture and assembly programming (based on the 6809 processor, although several other eight- and sixteen-bit microprocessors are surveyed), FORTRAN, COBOL, and advanced COBOL, and an internship program for seniors that places them in a commercial mainframe computer center for one semester comprise the remaining twelve hours. Courses in data base management systems and data communications are now in the planning stage.

Cost-Effectiveness. Up until about five years ago, there was only one route to follow in order to provide students with computing power: time-sharing. A time-sharing computer system consists of a central computer, called a mainframe, to which terminals are attached. Usually, the main computer and all the peripheral devices, such as disk drives, printers, tape drives, and so forth, with the exception of the terminals, are housed in a computer center that is not accessible to students. The costs are usually proportional to the size of the main computer and to the number of terminals. Microcomputers offer another route. A typical microcomputer usually costs less than a single terminal for a time-sharing system, not to mention the central computer.

Many institutions may have a significant number of microcomputers already on campus, as NCCC did. Located centrally in a computing center, these computers seemed to represent a low-cost solution for the beginnings of a computer science curriculum. We already had a substantial investment in microcomputers, which were being used to teach word processing, computer literacy, business applications, and computer programming. If the same computers could support the computer science program, we would avoid many start-up costs. When we established criteria to determine the usefulness of the more than thirty microcomputers already on campus, we found that some were more than satisfactory for our purposes. Previously, we were mainly interested in such user considerations as ease of use, availability of applications, and keyboard layout. Now, we carefully analyzed such factors as the operating system, the availability of standard computer languages, the editor, the assembly development system, the processor's speed, and memory capacity.

Some of the computers failed the test miserably. One brand required a different editor for each programming language. Some brands had limited memory capacity. Certain languages were not available or were limited to subsets of the standard implementations. Only one model would satisfy our requirements. We started with ten suitable machines with 96K main memory; five languages (BASIC, FORTRAN, Pascal, COBOL, and APL); an assembler development system; a general-purpose editor; an RS-232 port; an IEEE-488 port; several dual disk drive units, each of which supported one megabyte of on line storage; numerous printers; and a network to tie everything together. With this equipment, we determined that no additional hardware would be needed in order to implement the new program. If we had been forced to purchase a time-sharing computer with ten terminals, it could have cost us between $60,000 and $150,000 of new money.

Maintenance costs are generally lower for microcomputers than they are for time-sharing systems. Large computers usually involve expensive maintenance agreements. Small microcomputers can prove to be very economical with or without maintenance contracts. In fact, my experience over the past four years with more than forty microcomputers (representing five different brands and numerous models) has indicated that the annual repair costs for microcomputers are less than the cost of annual maintenance agreements.

Software is much more expensive for larger computers than it is for microcomputers. An average full-featured word processing program can cost up to ten times more for a large computer system than it does for a microcomputer system. In fact, it is not uncommon for software producers to offer the same program on both microcomputers and minicomputers and to charge a higher price for the minicomputer application.

One area could prove a serious problem for educational applications. Some software requires a licensed copy of the program for each and every computer. The cost of one such software package for all the microcomputers could outweigh any cost advantage of the equipment itself. Some software producers are recognizing this problem and offering multiple licensing agreements to educational institutions. It is now possible to implement a multiuser networking system with a central hard disk and obtain discounted licensing agreements based on the number of users.

Taking all the costs into consideration, we found microcomputers to be a cost-effective alternative. Even if we had needed to purchase all new microcomputers, we estimated that the cost savings would have been $100,000 over a five-year period. We are currently in the planning phase of a major expansion, where upwards of $250,000 will be spent on an academic computing system. We are still convinced that we can offer more to our faculty and students by investing in microcomputers.

Pedagogical Considerations. We still had to answer the question of whether microcomputers could fully support the learning experiences needed in a two-year computer science program. We reviewed our curriculum and tested major portions of it on the microcomputers that we had on campus. We tested the hardware for capacity and speed. We tested the systems software. We examined the languages, the operating system, the editor, and almost every component that was critical to support the courses. The hardware was capable. With a sophisticated eight-bit processor (6809), a standard eight-bit processor (6502), a 96K main memory, as much as ten megabytes of disk storage, networking, and several standard protocol ports, the hardware matched the performance of many minicomputers of just a few years ago. (New multiuser, multitasking, sixteen- and thirty-two bit microcomputers with up to one megabyte of main memory and eighty megabytes of disk storage are now available.) Although the speed was less than desirable, this did not pose a significant problem. However, it can prove aggravating to have to wait ten minutes or more for a sort. Faster compilers and microprocessors now available have greatly increased the speed of execution.

One important software consideration involves the availability of languages. Pascal, FORTRAN, BASIC, and COBOL are widely available on many microcomputers and in standard implementations. APL, PL/M, LOGO, RPG, LISP, FORTH, C, SAS, and many other languages are available on a more limited basis or in nonstandard implementations. Our computers were equipped with COBOL, FORTRAN, Pascal, APL, two different dialects of BASIC, and an assembler development system. Powerful operating systems are advantageous, and they are available on microcomputers. Although the operating system that came with our computers lacked such sophisticated features as concurrent processing, multitasking, windowing, and high-speed disk access, it was deemed sufficient for our needs. New operating systems like UNIX or derivatives of UNIX are available on some new microcomputers.

Problems were encountered in the teaching of COBOL. The microcomputer hardware could not support tape-driven hardware. Tape use, a feature of COBOL, has diminished over the years, and it was decided that we could live with this limitation.

One potential problem in the use of microcomputers is the absence of a common editor for different programming languages. As mentioned earlier, we found that some microcomputers used different editors for different languages. However, other microcomputers used only one basic editor for all the different languages, which obviated the need for spending time at the beginning of each course teaching students how to use a new editor. Another solution to this problem is to use a word processing program as an editor.

The experience of North Country Community College convinced me that state-of-the-art microcomputer hardware and software offers the sophistication necessary to support a high-quality two-year computer science curriculum. The reactions of universities to our program have been mixed. Clarkson College was not only receptive but enthusiastic about our program. Of course, Clarkson was the first college to provide all its students with microcomputers—the Zenith Z-100. Other universities indicated that our students would have to contend with a time-sharing environment when they transferred, and they felt that this might constitute a handicap. Some universities questioned whether the course content was up to their standards. However, a close review of the content indicated that in several courses we covered more than the universities did.

We have identified other pedagogical advantages in using microcomputers. Providing students with the entire computer system, not just a terminal and a remote communications link, gives them a good understanding of how all the components of a computer system work together. Setting up data files on a disk and accessing them are simple tasks that provide strong reinforcement when students can watch their computer turn the disk drive on, locate the file, and read and process the data. Students are more aware of the idiosyncratic nature of the peripheral devices, such as printers and disk drives. They are better able to understand concepts that they can witness. They come to view an operating system as a variable, not a constant. Too many students graduate thinking that all operating systems are very similar to the operating system used on the large computer system with which they worked in college. Microcomputers reinforce the concept of different operating systems for different operating environments.

One of the most important pedagogical advantages of microcomputers is that they are easy to learn about and to understand. This simplicity allows students to gain confidence through successful operation and programming of an entire computer system in a short period of time. Although the program is still in its first year, we are confident that this simplicity will enhance courses on data base management systems, data communications, and operating systems by offering students a wider variety of experiences and more direct control over the computing environment. A course in data base management systems (DBMS) can actually be more educationally sound on the microcomputer, because the student can determine which DBMS is best for the particular application and then design the database. When a computer science program uses microcomputers, the institution can afford to purchase several different DBMS packages (relational, hierarchical, and so forth). This gives the student an opportunity to work with several different DBMS structures, query languages, and applications.

Another advantage of microcomputers is the immediate feedback that they give to students as soon as the work is completed. Some time-sharing environments have significant turnaround times, which can discourage students. There is less hardware failure with microcomputers. If the central computer in a time-sharing environment goes down, all computing power is lost. A microcomputer-based curriculum strengthens the link between theory and application. It also increases the student's control over the computing environment and thereby provides for a well-rounded computer experience. Finally, microcomputers represent the machines that most students will work with on future jobs.

Practical Considerations. Student access to computers is critical. One of the major concerns regarding student access at North Country Community College involved the provision of computing power at four branch campuses, which are more than a hundred miles apart. While a time-sharing system could have provided such power, both the cost and the inherent problems that accompany such a long-distance communications network outweighed the advantages. The solution was to duplicate our main campus microcomputer center on the branch campuses, on a much smaller scale. Only a small fraction of the computing power would be lost if a computer went down. Also, microcomputers are independent workstations, and they are flexible to the needs of a changing campus, such as NCCC. They can be operated almost anywhere. Thus, we can shift our computing power to the locations that are in greatest need. Also, microcomputers are not as intimidating to students as minis or mainframes. Consequently, they encourage more students to make use of computing power. In addition, many adult students needed microcomputers and such popular software packages as electronic spreadsheets and word processing packages. In the near future, when most students will come to college already well versed in one type of a microcomputer or another, this knowledge and skill will be an even greater advantage for microcomputers.

Security seems to be a problem that is getting worse, rather than better, as the result of new technological developments in data communications. A major advantage of microcomputers is that they can be physically separate from the school's administrative system. In addition, a time-sharing system allocates a certain amount of auxiliary memory to each user. Therefore, both data and programs are available to any user who can figure out how to break the security scheme. With a microcomputer system, data and programs are on a floppy disk that is locked in an office file cabinet; backup copies are in a desk. If a time-sharing system accidently erases programs, they have to be entered again.

Microcomputers offer applications outside the computer science curriculum. It is not possible to list them all here. The key element is software availability. The general conclusion at which we arrived after researching the software for microcomputers is that microcomputers can offer most, if not all, of the academic applications that the larger computers offer. In some instances, however, the programs are not as sophisticated, or they cannot handle extremely large applications.

Implementation. Implementing the NCCC program took considerably less time than designing it did. We already had a computing center, which consisted of eighteen microcomputers. Only five were suitable for the computer science program, so we traded in some of the other machines and peripherals for the more powerful computers that we required. This left us with sixteen computers in all, ten of which could support the program, at no additional cost. A network controller provided shared access to a one megabyte floppy disk drive, and we had one dot matrix printer. We have added hardware since then. Now, we have twenty-five workstations, seventeen of which support the full curriculum on three networks. We have also added three high-speed dot matrix printers. The computing center is usually open from 8:30 AM to 10:00 PM Monday through Friday, from 11:00 AM to 4:00 PM on Saturday, and from 4:00 PM to 9:00 PM on Sunday. One faculty member receives three credit hours of release time for coordinating the center which is staffed by students. Ideally, a full-time technical assistant should be assigned to the center.

So far, we have encountered no significant problems that were not quickly resolved. However, we recognize that we have only offered the first year of the curriculum to date and that some critical tests are still ahead of us. We remain confident, based on our first year's experience and on our research, that microcomputers will provide the support required.

The Future of Microcomputer-Based Computer Science Programs

Microcomputers provide a viable alternative to time-sharing computer systems, and they can fully support a quality two-year program in computer science. Microcomputer implementation represents an effective, efficient, and productive use of resources for many institutions. The key element for successful implementation of such a program is careful selection of the microcomputer hardware and software. I would be very skeptical of curricula based on certain systems. Most of today's microcomputers are not designed for such an application, but a few are superb. I predict that microcomputers to be introduced within the coming year will be capable of supporting a four-year program—and more. Considering the facts that IBM has configured the IBM Personal Computer to emulate an IBM 370 mainframe computer (admittedly with scaled-down capabilities) and that some microcomputers on the market today already surpass the capabilities of some minicomputers, this prediction appears conservative.

There are many time-sharing systems in the world, and students should have some exposure to them. This appears to be the major argument of those in favor of time-sharing systems. However, a survey by Archer (1983) asked business and industrial employers to rank general categories of knowledge for computer science graduates. Knowledge of programming languages and general knowledge of computing were ranked first and second, respectively, and knowledge of equipment (hardware) was ranked last. This finding seems to suggest that employers do not perceive equipment-specific knowledge as being as critical as a good basic knowledge of computing, which microcomputers can easily provide.

The future for microcomputer-based computer science programs appears bright. IBM's entrance into the microcomputer market has made many mainframe advocates rethink their position on microcomputers. Many universities now use microcomputers with time-sharing computers to support their computer science programs. A new and much more powerful breed of microcomputer is rivaling the capabilities of the time-sharing system at a fraction of its cost. We must keep in mind what type of computers students will work with after they graduate. When we examine the current trend, we see that microcomputers offer students a good look at what the future may have in store. Certainly, that must be a major goal of any education.

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Administrators who are able to use word processing, electronic spreadsheet, and data base management software can extend their effectiveness on the job.

Microcomputer Applications for Community College Administrators

Dale O'Daniel

Increasing numbers of community college administrators are developing meaningful relationships with microcomputers. These relationships are developing from an awareness that the microcomputer is a useful tool in carrying out the tasks necessary to manage an administrative office. The typical administrator spends hours making sure that his or her administrative office turns out a steady flow of paperwork. This paperwork is often repetitious, and it usually involves the combining of separate pieces of information in order to produce a report.

Most administrators have a central data processing office at their disposal, but they have found that computer printouts are often very complex and that at the same time they do not provide the information needed. This forces them to take another step, that is, to take the raw data provided by the data center and massage it further in order to find the specific answers they need. They must then turn these data into the final report that is submitted to a board of directors, board of trustees, or other administrative unit. Even though the data processing department provides information that is necessary to the administrative office and that simplifies the work being done, the complexity of the information and the possible delay in getting the information causes today's administrators to seek other tools.

D. A. Dellow, L. H. Poole (Eds.). *Microcomputer Applications in Administration and Instruction.*
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I am an administrator, and I use a microcomputer in the administrative office to prepare timely reports from the raw pieces of information provided by the data center. In this way, the microcomputer complements the data center in completing the work load of the administrative office. However, the microcomputer can aid the administrator in many other paperwork chores as well. Even if an administrator is totally unfamiliar with the microcomputer as a machine, it takes no more than a few hours in front of the machine to determine that the microcomputer can solve a number of administrative problems.

As the administrator becomes more familiar with the machine and the whole spectrum of microcomputing, he or she realizes that most administrative problems have more similarities than differences across the different administrative functions. This allows the administrator to use general applications software, not specific user-prepared software, which is both expensive and time-consuming to develop. User-prepared software requires a programmer, who tailors a software system to the needs of a particular office or task. The cost does not end with the software product, because the system inevitably requires modification as needs and report formats change. It is not uncommon to spend multiples of the cost of a complete microcomputer system for user-prepared software. General application programs can solve many administrative work load problems.

Three Administrative Tools

General applications software falls into three distinct categories—word processing, electronic spreadsheets, and data base management systems—and most administrative tasks can be handled with one or more of these systems.

Word Processing. Most administrators have become familiar with the term *word processing*. Word processing basically means putting black ink on paper. Word processing electronically removes the labor-intensive and time-consuming elements from nonelectronic text editing. Most word processing software allows users to type, print, and revise documents with minimal effort. The systems use simple commands that enable users to eliminate tedious and repetitious typing and editing tasks. Following the prescribed command techniques, users can insert and delete text, rearrange text within a document, move text from one document to another, and store text for later revision and printing. Updating a letter or document is both fast and simple, and the need for retyping entire letters or documents becomes a thing of the past.

Word processing software makes it possible to produce large numbers of personalized form letters with very little time and effort. The text is simply typed into the computer as a form letter, and a list of names and addresses is prepared or recalled from memory and automatically merged with the body of the form letter. Thus, the correspondence coming out of an administrative office can shed the copied nonpersonalized look to become an individualized personalized piece of correspondence that well represents the office in the business world. The list of uses in the typical administrative office for electronic word processing is endless, and it grows daily as the office becomes familiar with word processing software.

Electronic Spreadsheets. Electronic spreadsheet software was born from the idea that many of today's problems can be solved with a calculator, a pencil, and a sheet of paper. All three tools are used daily in the typical community college administrative office. Since they are the same tools that we normally use to handle such day-to-day calculations as income taxes, financial ratios, and personal budgets, the community college administrator finds no great difficulty in using these tools in the office. Spreadsheet software combines the convenience and familiarity of an electronic pocket calculator with the powerful memory and electronic screen capabilities of the microcomputer. Spreadsheet software turns the monitor screen into a "window" that looks onto a much larger electronic sheet. The user can move this window in four directions in order to examine any part of the sheet, or the screen can be split to allow the user to see any two or more parts of the sheet at the same time. The sheet is organized as a grid of columns and rows. The intersections of columns and rows define thousands of entry positions. At each position, an alphabetic title or a number or formula to be calculated can be entered.

By writing on the electronic sheet, templates for variable pieces of information can create all sorts of tables, charts, and records. The template can be reused, which rules out the need for spending time reconstructing the sheet. Most spreadsheet software packages have formatting commands that allow the user to individualize the appearance of each entry, row or column. This feature allows the user to fashion forms that closely resemble prepared documents and forms. The power, and therefore the worth, of spreadsheet software is that the computer remembers the formulas and calculations entered on the sheet; if a number on the electronic sheet is changed, all the other related numbers on the sheet change instantaneously, and all the formulas within the template are recalculated automatically. Any community college administrator can see the value of using spreadsheet software to answer the many what if questions that normally surround such issues as budgeting and scheduling. Completing the same operations with a calculator, pencil, and paper takes hours of calculating, erasing, and recalculating.

The ability to save an entire electronic sheet on diskette allows the administrator to reuse the template created for any specific problem to solve future problems. An electronic sheet can be printed totally or in part on a printer for hard copy use. Most systems also make graphics available with a few simple keystrokes.

It takes an hour or two to learn the elementary features of most electronic spreadsheet software, and these features will allow the administrator to solve simple problems. As he or she uses the spreadsheet software, he or she masters increasingly complicated applications and discovers the broad range of features and commands that can be used as the need arises.

Data Base Management Systems. Data base management software resembles an electronic filing cabinet. Any items that an administrative office stores in the traditional filing cabinet can now be stored electronically using the microcomputer and data base management software. All administrative offices are involved daily in record keeping and paperwork. Typically, the information stored in filing cabinets is used to prepare reports that reflect the data. By computerizing such files, the task of selecting and exhibiting data becomes one of electronic, not of physical, manipulation. Information stored in the microcomputer is stored under a record name; the record resembles a folder in the traditional filing cabinet. Each item in the record is an item of data related to the particular record. So, whether the administrative information is related to students, personnel, inventory, or purchasing, it can easily be computerized with data base management software. The size of the task and the amount of data necessary to accomplish the task are the only limiting factors. The larger the volume of records to be stored in the system, the larger the capacity of the microcomputer and software must be.

The typical community college administrative office can operate quite well with inexpensive data base management software. Whether the job is large or small, the basic procedures are similar. The stored records can be retrieved selectively and viewed on the microcomputer screen, or they can be printed as hard copy. Any pieces of information in the system can be selected by using a particular sort procedure. If errors are made or if critical data elements are omitted, it is relatively easy to change the file structure and insert the new data without losing data already stored. Even the novice microcomputer user can accomplish such tasks.

The Impact of Microcomputers on One Administrative Office

The microcomputer has had a drastic impact on the Administrative Affairs Office at Chipola Junior College. The primary administrative responsibilities of this office are budgetary accounting and control, personnel, data processing, and facilities.

Impact on People. The first way in which microcomputers affected the administrative affairs office was manifested as fear of the machine itself. This fear was soon relieved by basic instruction in the use of the machine, which was coupled with some private hands-on time for each individual in the office. Once staff saw how much individual effort could be saved or redirected by using the microcomputer to accomplish routine administrative office tasks, fear of the machine turned into addiction to the machine. Each routine task that became computerized led to the computerization of other tasks and to an overall desire to computerize any and all office functions.

Invaluable though they may be, data base management systems, word processing packages, and electronic spreadsheets cannot handle every paperwork task that the computer-minded administrator may have to accomplish. However, the number of tasks that can be accomplished with the microcomputer and general applications software is surprising when individuals see the time-saving capability of the machine and the software.

Impact on Roles. The impact on roles played by individuals in the administrative office is evident from the redefinition of roles. The traditional definitions of boss and secretary or of boss and clerical employee change drastically. For example, I find that word processing software often makes it more cost- and time-effective to sit down at the computer myself and prepare a routine memorandum for circulation than it does to have the secretary take dictation or transcribe a tape. Also, using the same word processing software, my secretary can prepare a rough draft of the memorandum; I need only to proofread the document before it is placed in circulation. The clerical or secretarial employee who uses spreadsheet software can propose many what if questions and submit the answers to the administrator for examination prior to administrative action. Who in the office needs the information and how critical the need is dictate who actually gathers the data and prepares them in report format. As each member of the office staff becomes familiar with use of the micro and related software, any staff member can accomplish routine tasks.

Impact on Time. In the typical administrative office, there is never enough time to accomplish all the tasks that need to be done. By allowing the machine to handle the routine, labor-intensive paper-handling tasks, individual productivity is greatly enhanced. While the resulting enhancement does not normally allow personnel to be reduced, it does increase the productivity of personnel and office staff. Marginal tasks that never seemed to get done in the past can now be accomplished by tapping the increased productivity that results from the microcomputer.

The ability of many employees to use the microcomputer frees up the time of the supervisor who would normally have to accomplish the task. By using the micro, many more tasks can be accomplished during the workday than regular office staff could have accomplished manually. As demands for reporting and accumulating data increase, the micro will become a more important tool for the typical administrative office than it already is. For example, the budget-making process at Chipola Junior College historically involved several months of calculation and recalculation of proposed and recommended budgets in an attempt to balance expenditures with revenues. Now, that process currently takes less than a month, thanks to the microcomputer. From the initial submission of proposed department budgets on floppy disks to the final budget document submitted to the Division of Community Colleges for approval, all steps in the budget-making process at Chipola Junior College are completed with the microcomputer and general applications software.

Spreadsheet analysis allows the what if questions common to budget making to be answered with simple keystrokes on the microcomputer; the resulting impact on the total budget is illustrated instantaneously. The budget-making process then becomes one of moving expenditures or of increasing and decreasing expenditures, as the case may be, so that the overall budget remains within revenue limitations. The spreadsheet is recalculated each time a what if question is asked, and the resulting increase or decrease in the overall budget is reflected at the same time.

Another example of the impact on time at Chipola lies in the capability of electronic communications. By means of a modem, the microcomputer can be connected with other computers over ordinary telephone lines. The sharing of information with sister institutions in the community college system can now be accomplished electronically simply by transmitting a prepared template or working file to another institution that receives it on compatible computer equipment. A spreadsheet template to be used in budgeting can be transmitted to a sister institution for use in a similar budgeting environment, which saves times for the sister institution. Similarly, word processing files can be transmitted to sister institutions electronically, which saves the time and expense needed for preparation.

A third example of impact on time is the communications networking that becomes possible when the microcomputer is used as a terminal. The community college system in Florida has a communications network called the College Online Information Network (COIN). All twenty-eight community colleges in the state are linked to one another and to the community college division office. By using network, messages can be sent and received at any and all institutions in a timely and inexpensive manner. The community college division office maintains a data base of pertinent information on individual colleges and on the system as a whole. The individual community college can access these data via the COIN system for viewing and preparation of reports. Data needed in reports required by the division can be submitted to the division through the COIN system, which eliminates the necessity for preparing hard copy reports at individual institutions.

Impact on Organization. Computerization of office work tends to clarify the work to be accomplished. For example, the time needed to accomplish routine office tasks is now based on the ability of the microcomputer to gather and report data. The office day can be planned for the most effective use of personnel and machine. The resulting paperwork assumes a professionally processed look.

In the past, the personnel office at Chipola Junior College maintained hard copy files on all applicants for positions at the college. Many filing cabinets were needed to hold the large amount of paper representing the applicant pool. This information is now placed in the computer using the data base management software system maintained by the personnel office. When a position is declared open by college administration, the personnel officer uses the microcomputer to sort all applicants who have listed that position as their preference. These applicants receive letters of notification about the position opening, thanks to the microcomputer's word processing capabilities. A form letter stored in the microcomputer is merged with a file containing names of applicants. The resulting letter, which is printed on a letter-quality printer, is a personalized original that any college office could be proud of. The process saves many hours of file retrieval and correspondence preparation.

The impact on organization within the college business office is also significant. In the past, accounts receivable, which reflect monies owed to the college by various agencies and individuals, were maintained as hard copy files. Each month, files had to be pulled to compare amounts owed with amounts paid. The microcomputer and data base management software now accomplish that process electronically by filing the accounts receivable with amounts and due dates. These accounts can then be recalled electronically and sorted on amounts, names, or due dates. This procedure has organized business office paper handling and account collection into an efficient and time-saving process.

The preparation and maintenance of salary schedules provides a third example of the microcomputer's impact on the institution's organization and management. Individual salary schedules are prepared and maintained for the different types of employees within the institution. Each salary schedule is based on an annual salary, an hourly rate of pay or both. In the past, any changes in existing salary schedules involved many hours of calculation and recalculation, then final preparation. That process can now be completed with the microcomputer and spreadsheet software; salary schedules can be raised by particular percentages, fixed dollar amounts, or both. The resulting new salary schedule can be reproduced for use in the budget-making process. Any combination of percentage increases and fixed dollar amounts can be examined merely by introducing the increase or decrease in percentage or dollar amount into the electronic spreadsheet; the resulting net change is reflected instantaneously.

In the past, each change examined for budgetary impact represented many hours of individual calculation. A further enhancement of this process has been accomplished by placing individual employee salary amounts within the existing spreadsheet template. Each employee is assigned a place on the existing salary schedule. As the salary schedule is adjusted with the spreadsheet software, the net effect on the individual's salary and fringe benefits is immediately evident. These amounts are then totaled so that the cumulative effect of all individual employee salaries on the total budget of the college can be seen. The effects of any proposed change in salary or fringe benefits for college employees can be viewed in a matter of moments, as well as the total financial impact of the proposed salary increase.

Impact on Dollars. The initial impact on dollars is substantial. A complete microcomputer system, including the microcomputer itself, disk drives, letter-quality printer, and general applications software, represents several thousand dollars. However, the overall impact on dollars can be a substantial reduction in total costs of operations due to the increase in the productivity of the administrative office. When the investment of $5,000 to $7,000 for hardware and word processing, spreadsheet, and data base management software is compared with the cost of personnel to accomplish the same tasks, most administrative offices can justify the cost of installing a microcomputing system.

Before, After, and In Between. When I trace the implementation of microcomputers in the Administrative Affairs Office at Chipola Junior College, I find three distinct phases of implementation. In the before phase, staff wonder how they can become familiar with a complicated electronic device that is supposed to help them accomplish their tasks. The individuals involved answer their own questions as they become familiar with the machine and learn that a short period of instruction and hands-on experience enables them to use the machine to enhance their ability to perform specific office functions.

The after phase of implementation results in the question, How did we ever get along without the microcomputer? No one in the office can envision the level of productivity that we now enjoy without the microcomputer.

In the in between phase, the questions involve the who, what, where, and when of implementation. In our case, the who involved who would use the machine most and for what purposes. The what involved the particular devices needed to accomplish the desired tasks. The where involved the most appropriate applications of microcomputers within the typical administrative office. The when involved the order in which the computerization of routine office work should be accomplished.

The lessons learned in implementation were many and sometimes painful. The painful lessons came when we saw that there were limitations on what the machine could do and that hours of effort were necessary to accomplish complex tasks for the first time. Another important lesson learned was that the computerization of paperwork chores should not be attempted in an all-inclusive environment. Rather computerization should take place first on that portion of paperwork that causes the most problems; only then should it build toward the complete computerization of paperwork.

Overall, I think it can be said that all Administrative Affairs Office staff are proud of their accomplishments in using the microcomputer and general applications software to complete tasks that in the past we could only have dreamed of completing, thanks to time limitations.

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The age of library microcomputing is in full force in community colleges. Keeping up with new developments in microcomputing at two-year college learning centers requires literacy in computer hardware, software, and telecommunications.

Application of Micros in Libraries and Learning Resource Centers

Eleanor M. Carter

Libraries and learning resource centers (LRCs) at community and two-year colleges have found a host of applications for microcomputers. These applications range from direct patron services to automation of administrative and library support functions. Community college LRCs have more than realized Simpson's (1978, p. iii) prediction that "as librarians cope with reduced budget, decreased staff, and increased demands for services, microcomputers will take a significant role in library automation by providing low-cost systems, solving specific library problems, and performing in distributed systems." Not only have community college librarians turned to automated applications in order to survive, but they have assumed a leading role in introducing faculty and students to microcomputers via a range of user services.

Cobleskill's LRC

The learning resources center on the State University of New York's Cobleskill campus has a strong commitment to print and non-

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print resources. The collection includes 75,000 books, 40,000 audiovisual volumes, a circulating equipment collection of 175 items, and other specialized collections. One floor consists of a centralized learning laboratory facility. There, a minicomputer runs a thirty-two-station interactive learning system. The total comprises 120 stations with audiovisual playback equipment, 23 microcomputer stations, an audiovisual reserve area, a peer tutoring center, and a career study skills development area. The lab allows students with varying learning styles to work independently at their own pace. Demonstrations and equipment encourage hands-on or active learning. More than eighty courses each semester have assigned work in the lab. Some classes meet entirely in the lab for mainline instruction. Students scheduled for classes in the lab have a chance to work with instructors on a one-to-one basis.

In many courses, students use microcomputers at the learning resources center to complete their work. Students in mathematics, data processing, science, agriculture, and food service have access to Apples and IBM Personal Computers to complete coursework. Since 1979, when microcomputer services were introduced in the LRC, staff have been asked to speak on organizational concerns at library conferences. Topics presented in this chapter are discussed in the context of decisions made at Cobleskill. Where possible, solutions that others have found are also included.

User Services

Microcomputer-related user services include provision of microcomputer equipment and software that patrons borrow or use in the LRC and professional consulting services to assist in the selection and use of equipment and software.

Equipment and Software Access. Compact versions of a variety of microcomputers have been packaged for portability which enables LRCs to loan micros to patrons from the circulation desk. Thus, it has become a relatively simple library circulation transaction to loan computers and computer software programs to faculty and students. Besides the microcomputers that go out on loan, many more LRCs maintain permanent collections of microcomputers and software that patrons can use on the premises. The most common uses to which patrons put these materials are to develop computer literacy; to obtain hands-on experience with a significant new technology; to learn new content and skills; to enrich course content with drills and tests; to remediate course content or skill mastery; to remediate basic skills; to experience an alternative learning strategy to classroom lectures, textbook reading, and group discussion; and to explore careers.

Many community colleges have identified computer literacy standards for all students. Since microcomputers are already pervasive in the work sites that employ community college graduates, most community colleges feel an obligation to produce graduates who have a minimum level of understanding about the language, operations, and applications of computers. The library is an effective and inexpensive means for providing all students with microcomputer experience. A host of computer literacy software can be used with micros to achieve minimum computer knowledge and competencies. Students can complete all this software independently on library microcomputers. Library microcomputers can also provide supplementary and practice experiences for students in computer literacy classes taught by community college faculty.

At Cobleskill, many patrons learn about computers through their classes or through computer literacy courses. For those who have no such formal opportunities, computer literacy software is provided for their independent use. To make sure that all patrons are prepared to use our microcomputers, we administer a computer literacy test to those who do not appear on class rosters as having received formal instruction. The test combines questions taken from commercially produced teaching materials with questions produced locally that enable us to make sure that patrons are aware of use features of our own microcomputers.

Where microcomputers and commercially produced software are available in libraries, community college faculty have the option of assigning computer-assisted instruction to students to complete outside the classroom. Such assignments can supplement classroom uses of computers, or they can be independent of other computer use. In these cases, the assignment to use instructional microcomputer programs becomes comparable to assigned reading, audiovisual viewing, and listening. For LRCs newly involved in providing software collections, it is advisable to arrange meetings with faculty at which the potential uses of microcomputer software for students can be demonstrated and ways of locating appropriate microcomputer software can be explained. Vendor days can also be productive in generating interest in this service. Most software distributors are happy to visit the campus for a day. A well-arranged vendor day that many different distributors attend can give faculty numerous opportunities to examine software at their convenience.

Community college students are also using microcomputers to access career information libraries. In connection with research conducted by Southwest Virginia Community College, Moore and others (1981) describe seven computerized information systems, some of which can be adapted to include important local career information. The study also details the advantages of housing a computerized career information center in the college library.

Another important patron use of microcomputers in libraries relates to computer programming. In community colleges where data processing or subject courses require programming experience, students can bring blank computer disks to the library and use the microcomputers to write programs, particularly to develop computer-assisted instruction for subjects that have not yet been programmed.

Professional Consulting Services. In the same way that provision of equipment and software in community college libraries parallels more traditional book and audiovisual services, the consulting role of the librarian and media specialist is already well established. It is a logical extension of professional reference, materials selection, collection development, equipment selection, and bibliographic instruction consulting services to apply the same techniques to microcomputers and microcomputer software. LRC professionals are being asked for advice about selection and use of microcomputer hardware and software. To provide such service, they use the same techniques that are successful with any equipment or software selection. They help patrons to assess their individual needs to locate and interpret selection aids, identify and consult with experts, and to preview equipment and software. Many professionally researched lists of criteria for both hardware and software are available to the professional, who can use them in working with patrons to choose hardware and software. Of particular interest to LRC professionals will be Warden and Warden's (1983) comparative description of microcomputers for libraries, Chambers and Haycock's (1983) annotations of periodicals useful for microcomputer selection and use, and Laubacher's (1982) list of microcomputer information sources.

LRC professionals also provide a microcomputer-related user consulting service in the form of user instruction and orientation. They show faculty and students how to operate microcomputers available in the library and how to follow established library procedures for accessing microcomputers and software. LRC professionals must become proficient in using these materials themselves, and they must train all appropriate LRC staff to play a role in the provision of services. Where community colleges have computer science and data processing curricula, some libraries have successfully used peer student tutors to assist with consulting services. At Cobleskill, student tutors have two major assignments. They assist peers with programming questions and concerns, and they do routine cleaning, maintenance, and repair of microcomputers. These activities are built into a three-credit course of independent study for promising students.

User Control Systems

Many who learn about microcomputer user services in libraries seem to find the concept unusual and surprising, often even somewhat threatening. Why, one might ask, do we think of microcomputer user services as outside the mainstream of regular library services? LRC professionals solve hardware and software problems all the time. We follow established patterns for good selection to select materials for our collection. If micro software is the best source for information that we seek, then we build collections of software and solve the cataloguing and storage concerns as we would for any other material. We help patrons to locate and use microcomputer software as we help them with all other forms of information in our libraries. What is different is the technical considerations involved in setting up user control systems, which include user priority and time limit systems, equipment security, materials handling and reservation, equipment maintenance and repair, collection and reporting of usage data, and troubleshooting techniques.

Essentially, each user control concern involves decision making based on the organization of the facility, the availability of staff, and the adequacy of microcomputer resources. When the equipment available is limited, some libraries identify user populations to receive priority over others. For example, students with assignments may have priority over patrons who wish to use micros to play games, or game playing may not be allowed at all. The problem of limited resources can also be solved or alleviated by setting time limits on the use of microcomputers. At Cobleskill, we do not allow game playing on the micros because of the heavy demand for serious work. We have a one-hour time limit, which is enforced only when all machines are busy. When all machines are in demand, we create a waiting list of students and invoke the one-hour time limit. We publish assignment due dates when they are known so that patrons can anticipate busy times and plan their work accordingly. Despite these arrangements we have had more than 300 names on a waiting list in a single day during peak periods.

The security of library resources is always a concern, but it is a special concern for expensive and popular microcomputer hardware and software. Libraries have to decide where to locate microcomputer hardware to ensure maximum visibility. Where this is impossible, commercially produced but expensive security devices can be used. If technical staff are available to the LRC, it becomes possible to hard-wire equipment to library carrels and to convert the microcomputers to a key operation. When this is done—the cost is generally very small—keys to activate the computers can be signed out from a library service desk. We opted for keys because we found that the on–off switches on our microcomputers were especially vulnerable and required frequent replacement. By automatically converting all micros that we purchase to a key system, we can guarantee 1,000,000 actuations per key. The key systems pay for themselves within a very short time. Information on key systems and details of conversion can be found in Poole and Carter (1983). Keys have the added benefit of providing data on use and users, but their use depends on the availability of staff who can implement the option. An alternative security measure is the coin-operated computer described by Wollman (1982).

Software concerns include decisions about the number of copies of programs needed to accommodate users. For security of materials and because of heavy demands, libraries frequently place microcomputer software on reserve and sign it out to patrons. This has the advantage of providing usage data, but the practice also requires staff to implement. Cobleskill chose to place most of the microcomputer software on reserve and to allow it to be used in the lab only. However, some items purchased for faculty use in developing computer-assisted instruction circulate with our portable circulating microcomputers. Making decisions about the number of copies to purchase requires cooperation from faculty who project uses. It also requires extensive communication among program areas. To cope with the problem, Cobleskill's LRC is establishing a software procurement clearinghouse. When any individual is considering purchase of software, the clearinghouse will communicate with the entire campus to assess the extent of interest in the software. Knowing the number of software packages needed will enable us to negotiate corporate licensing fees that can reduce the cost of additional copies. Vendors are particularly accommodating when the software is to be used for instructional purposes. The clearinghouse offers the advantage of making software dollars go as far as possible without unnecessary duplication of purchases, and it also complies with copyright regulations.

Equipment maintenance and repair are perhaps the most serious considerations in a user control system. Disk drives and printers should be rotated for even wear, and the heads on the disk drives should be cleaned regularly. Minor mechanical problems as well as paper shortages must be anticipated. Service contracts must be evaluated against pay-as-you-go service, and a decision must be made. One alternative to paying an outside service agent is to do the repairs in house. Most of the major microcomputer manufacturers provide training and diagnostic packages for a price. If the LRC has a capable technician, it is usually more cost-effective to purchase the necessary training and equipment and do one's own repairs. Service decisions are detailed by McClain (1982), and service training opportunities can be located by direct contract with the manufacturer. Cobleskill tried both ways. In the beginning, we paid outside technicians to repair our micros, but we incurred such heavy expenses that we opted to do our own.

Usage data are critical for determining and justifying future hardware and software needs. It is extremely cumbersome to obtain accurate, usable data manually. Inexpensive time-lapse meters can be attached to microcomputers to determine the amount of time in which the machines are in use. Key sign-outs, reserve materials transactions, or coin meters are useful for determining the number of users. It is also advisable to keep maintenance logs of downtime and to record names on waiting lists if demand is heavy.

Troubleshooting plans are essential when establishing user control systems. It is important to establish what LRC personnel can and cannot do when patrons report problems using microcomputers. It is particularly helpful to observe common occurrences and to post helpful hints for patrons near the microcomputers. A packet of specific and detailed technical guidelines is available from the author.

Administrative Applications

The microcomputer is a popular choice for administrative applications in community college libraries, because it is handy, results are fast, you are not dependent on others, and you can finish a project while others are planning their systems. The use of microcomputers for such library support functions as serials check-in, acquisitions, circulation, and interlibrary loan have been well documented by Chen and Bressler (1982) and by Hines and others (1982). All these applications are found in community college libraries. Cuadra (1983) describes how the microcomputer can link libraries with on line data bases to facilitate patrons' search for information. With necessary software, communications equipment, and related hardware attachments, microcomputers can be linked to compatible computers throughout the nation and beyond. The microcomputer can access large systems, and it can be used for distributed information processing. Community college libraries are using the microcomputer in the same way.

Administrative applications of microcomputers to such functions as data gathering and analysis, word processing, inventory control, time management, data base management, and electronic filing are less well documented. Microcomputers are being used to do jobs often repeated, jobs that cannot be done manually, and jobs that microcomputers can significantly cut the time required for doing, so that limited staff can be reallocated to other tasks.

Data Gathering and Analysis. There is abundant commercially available software that enables community college libraries to capture and analyze data quickly, accurately, and efficiently. Electronic spreadsheets, statistical packages, and graphics programs facilitate the organization of budget and planning information, library usage data, comparative library data, and trend data in tabular, graphic, and narrative forms.

Word Processing. Commercially available word processing programs allow community college libraries to generate reports, correspondence, bibliographies, serials lists, directories, newsletters, manuscripts, and mailing labels, to name only a few. In some cases, specialized programs designed for particular library operations, such as bibliography production, are available, and community college librarians are using them. Often documents generated in libraries need frequent revision to reflect changing collections and services. Word processing enables revisions to be accomplished without total retyping.

Inventory Control. A variety of commercial software designed to store and maintain inventory records is being used in community college libraries. Film and audiovisual holdings are popular choices for inventory control, as are equipment and supplies records. Inventory systems make it possible to keep track of equipment vendors, model numbers, serial numbers, location, and condition. Such records can be expanded to include experience with vendors, cost comparisons, replacement parts, dates of servicing, and any number of local options.

Time Management. Community college libraries can and do use commercial software to create and manage schedules, including appointments and deadlines. A file of important activities that recur at approximately the same time each year can be created for time management purposes, and the activities can be cross-referenced to the data needed to carry them out. Reservation lists of reserved films, equipment, and rooms are easy to keep, maintain, update, and search.

Data Base Management. Small local data bases are managed by microcomputers in many community college libraries. These data bases include vertical file holdings; internal report literature; authority files; local, state, and regional resource and referral services; directory information; and frequently encountered reference questions and answers.

Electronic Filing. Commercial filing programs are used by community college libraries for local indexing and local information files. Many libraries have indexed local newspapers, books, documents, and reports. Some libraries support curriculum for which supportive periodical literature is not indexed. Microcomputers provide a means for launching a local effort to index important resources that larger, broader-based data base organizers overlook. The advantage of electronic filing is that labor-intensive files are automated, which frees staff for more direct user services.

Information Exchange

Librarians at all levels are investigating and creating ways of best responding to the variety of possibilities and products related to microcomputers. To identify the individual community college library users of administrative programs, the reader can write to Action Exchange ("Action Exchange," 1981), describe his or her particular interest, and ask for help from experts.

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Institutions that try to serve adult learners in the 1980s and 1990s with 1960 style educations will be diminishing service to adults, communities, and the nation. The preoccupation with new programs of study must give way to new ways of learning highly individualized, self-paced, computer-assisted experiences that respond to adults' changing needs.

Computer-Assisted Adult Learning and the Community College Response

Barry Heermann

Microcomputers are dramatically extending the learning opportunities of adults nationwide. Producers and marketers of courseware are bringing compelling new educational programs to homes and businesses, and other programs are on the way. Adult learners can benefit enormously from low-cost, easy-access computer-assisted learning opportunities. Given the work- and home-based locations of such learning, what is the appropriate community college response? Can community colleges expand their vision of themselves soon enough to become facilitators of this learning on campus and in the community? I believe that they must if they are to continue to meet the needs of adult learners in the 1980s and 1990s.

Recent findings suggest that adult learning takes place in locations that often are radically different from those previously assumed. The circumstances are different. The methodology is different. The curriculum is different. The students are different. Most learning does not take place under institutional auspices. The 500 or so hours of learning endeavors that adults engage in each year tend to be self-

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guided and independent, and only infrequently are they under the supervision of postsecondary institutions (Tough, 1978). The curricula of the workplace, the home, the family, and the church occupy considerably more of the adult learner's time and interest than the curriculum of the college.

With the advent of the microcomputer, it becomes safe to assume that adult learning will be further skewed to work- or home-based locations remote from colleges and universities. This does not have to produce serious dislocation if community colleges choose to develop the linkages necessary to incorporate this new learning modality.

A Plan of Action for Community Colleges

In an effort to respond to the challenges facing community colleges, a number of specific actions are required. This section discusses those actions in detail.

Assessing Computer-Assisted Learning. In an earlier publication (Heermann, 1977), I argued that older, adult students deserve better than they are getting. Their increasing numbers and the important learning that they bring to campus should make educators pay attention to their needs and contributions. What they have learned is often due not to traditional schooling but rather to work experience, family management, travel, volunteer work, industrial and public-sector training programs, and self-initiated study and reading. That educators have not taken more definitive action to assess and recognize this learning suggests that they are preoccupied with younger students and with teaching, not with learning.

Procedures for valid and reliable assessment of nonclassroom learning have been treated extensively in the literature. The Council for the Advancement of Experiential Learning (CAEL) has led this movement, and it has excellent material and human resources to guide institutions that have not gained this critical competence. Exemplary assessment programs can be observed at Sinclair Community College (Oh), Delaware County Community College (Pa), Watcomb Community College (Wa), and Santa Ana Community College (Ca).

These assessment programs of prior learning assume critical new importance as adults engage in learning experiences delivered by microcomputers in their homes and workplaces. This learning deserves to be assessed, and it should be recognized to the extent that it is college-equivalent. The community college can prepare for the computer age by understanding itself as an assessor as well as a facilitator of learning.

In addition to assessing prior learning on a student-by-student basis, colleges should also desire means for evaluating the effectiveness of corporate training programs, which are increasingly computer-assisted. When faculty have evaluated and determined such corporate training to be equivalent to the institution's course offerings, this training can be articulated toward degree requirements, permitting recognition in much the same way as credit is articulated from transcripts of postsecondary educational institutions.

One outgrowth of such evaluation could be the development of alliances with business and other community institutions in the acquisition, use, and crediting of computer-assisted education programs. In these ways, adults would be recognized for their learning independent of its sources or circumstances.

Acquiring Microcomputers. The computer industry is changing so rapidly that it is difficult to keep up with new products and innovations. Certain trends, however, are becoming obvious. Mainframe computer systems will become less important as excellent new stand-alone software for microcomputers becomes increasingly available.

The Apple microcomputer is firmly entrenched in the home market and in the schools, and the IBM Personal Computer is the favorite of the corporate community. As community colleges seek to acquire microcomputers as alternative delivery systems, they would be well advised to select brands that are widely used in homes and the corporate community. Courseware should be compatible with Apple and IBM equipment, as adults are familiar with its operation and as they have ready access to such equipment for work- or home-based study.

Enhancing Faculty Competence. Computer literacy is particularly relevant to the importance of faculty development in the realm of computer-assisted learning. Faculty development is important in order to raise awareness about the potential of this learning modality. Faculty should be encouraged to incorporate professionally produced courseware into their instructional process, to reconceptualize the learning process so that they can accommodate adults who prefer home- or work-based learning, and to guide local developers of courseware. I consider the first two reasons to be the most compelling basis for faculty development.

I predict that in the next ten years most community colleges will take advantage of the high-quality courseware available from major producers. They themselves will produce a small percentage of their computer-assisted education programs. The experience in this regard will be much like that of instructional television, where the preponderance of telecourses is professionally produced; the result is a higher level of instructional effectiveness than individual colleges could achieve by themselves. The relatively low cost of professionally produced courseware and the high cost of instructional design, which includes faculty development as well as computer programming support, should encourage the use of high-quality professionally produced courseware.

Why should colleges defer in this regard to professional courseware developers? Lobello (1982) points out that software development is labor-intensive and time-consuming; programming always takes twice as long as planned; testing always takes twice as long as planned, and it generally takes twice as long as programming; input-output considerations always create unexpected problems; and programming for unsophisticated users (like most students) requires sophistication from programmers.

Choosing Professionally Developed Courseware. Decisions regarding the selection of courseware to enhance community college instructional programs should be based on a series of pedagogical factors, including learning strategy, visual impact, ease of use, learning assessment, humanizing qualities, experiential learning, and supplemental materials.

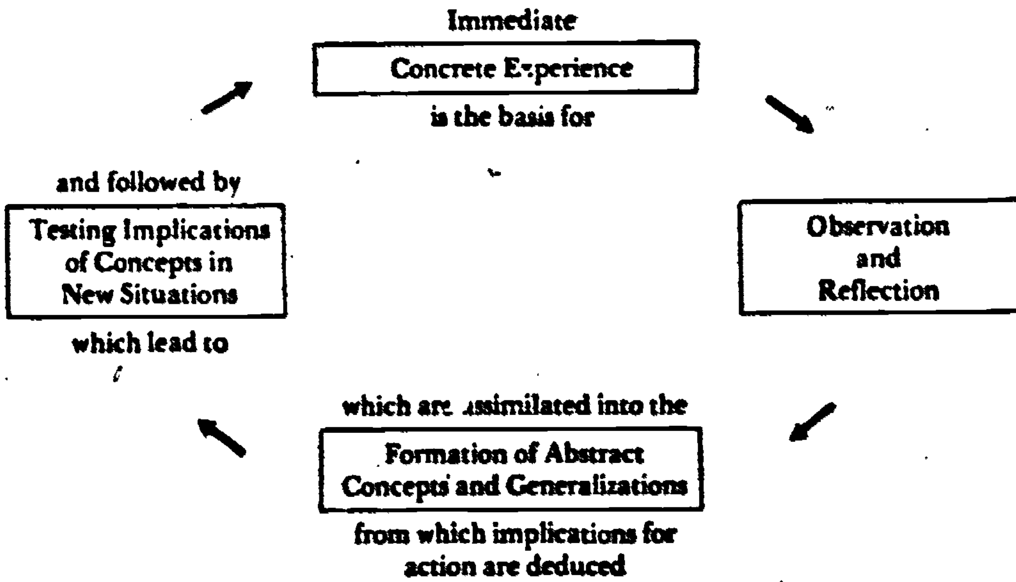
Learning Strategy. The best computer-assisted learning programs are attentive to both cognitive and affective learning. Programs narrowly focused on Bloom's cognitive domain, particularly at knowledge levels, only incompletely exploit the power of this medium and its potential for facilitating a rich learning experience. A book can accomplish the presentation of knowledge and principles more effectively and at lower cost. Computer-assisted learning that is merely page turning misses the point.

Kolb's (1976) learning cycle is especially instructive in conceptualizing good computer-assisted learning. Kolb defines learning as the interplay of polar opposites, namely concrete experience and abstract experience on the one hand and of reflective experience and active experience on the other. His cycle is illustrated in Figure 1.

Most computer-assisted education has focused on skill development in mathematics, grammar, or other relatively linear and rote areas. Accordingly, drill practice has been the prevailing methodology. This represents an excellent, though limited, use of the computer. Many of the critical curricular areas offered by the community college encompass entrepreneurial and interpersonal skills, which have only recently been addressed by computer-assisted education developers, with varying degrees of success.

Much computer-assisted education consists of the abstract presentation of data and theory far removed from the realities being studied in such areas as teaching, leading, counseling, motivating, sell-

Figure 1. Kolb's Learning Cycle



Source: Doherty and others, 1978.

ing, persuading, and other interpersonal realms. The observation and reflection that flow from this presentation tend to be overly intellectual and depersonalized, providing limited insight about appropriate action.

Just as traditional education has emphasized abstract principles and knowledge without direct experience of the realities being studied, computer-assisted education risks automating the most ineffectual assets of traditional education. Thus, the best computer-assisted education programs engage the learner in real-world situations, encouraging observation and reflection in the presentation of abstractions and generalizations and culminating in the application of learning to new situations.

Visual Impact. Computer-assisted learning programs can be visually interesting if they tap the computer's full graphic and color capabilities. The impact of graphics (persons, things, ideas) and of color as aids to learning should never be underestimated.

Three-dimensional models offer especially interesting possibilities, since color and shapes can reinforce important concepts and paradigms. Three-dimensional models are an excellent presentation mode, visually clarifying the interrelationships of critical theories and concepts. Adults have come to expect high-quality color resolution and good design in other media and they will accept no less from the computer. Therefore, esthetic considerations should play a part in selection of computer-assisted learning programs.

Ease of Use. Computer-assisted education materials should be easy to use, and frustration in loading, starting, and processing through the program should be minimal. Menu options should be clear, and instructions for accessing various materials should be easy to understand. The best menu presentations indicate interrelationships between units and subunits and make it easy for users to access subunits of material. Learners should be able to proceed at their own pace. Easy-to-use commands should make it possible both to repeat and review material any number of times and to bypass material that has already been mastered.

Learning Assessment. The most effective computer-assisted education programs have integral assessments that provide learners with immediate feedback, individualized responses, and remediation for given scores. Programs that fail to incorporate assessments do not fully use the strategic capabilities of the computer immediately to record, analyze, and report a vast amount of data concerning their effectiveness to learners—information that in the past required weeks to score and a faculty member's or counselor's time to interpret.

Assessments of knowledge and skills can be readily accomplished through review questions or exercises. Computer-assisted learning can also provide case analysis or simulations that allow learners to apply theories studied. Programs that assess attitudes in addition to knowledge and skills and that provide normative data allowing learners to compare themselves with national samples are especially valuable. Learners are then able to receive private diagnosis on how they might change, in addition to assessments designed to determine mastery that are reported to faculty.

Humanizing Qualities. Computer-assisted education can foster personal awareness in a way that other mediums cannot. Increasingly, I am convinced that the most exciting use of the computer as an educational delivery system lies in asking the right questions. The Socratic method can be enhanced and embellished with computer-generated remediations tailored to learners' responses that promote self-awareness and understanding. Computer-assisted learning can, in a highly confidential manner, provoke new awareness and illumination, thereby humanizing the learning process. For example, life and career planning can be facilitated through a highly person-centered process that engages the learner in consideration of his or her own values and beliefs. Open-ended questions allow learners to record their own insights and key life and career events. Such a program permits learners to uncover their own strengths and weaknesses, which promotes action planning.

Experiential Learning. Experiential learning which immerses the learner in problem and conflict situations, can be facilitated by the computer. Computer-assisted learning can engage learners in simulations, case analysis, and role-playing exercises. One benefit of computer-assisted learning in this regard is its consistent portrayal of real-world conditions in an interactive format. Programs that provide immediate feedback on the effectiveness of the role assumed or the solution offered are now available. These programs process the learner's responses and branch to various analyses depending on the learner's solution.

Learners should have significant opportunities to apply principles and theory in which they have received instruction. Computer-assisted programs in management involve learners with their work group and relate action planning to performance improvement. A problem-solving program features an on line problem resolution process that allows learners to analyze their solutions to immediate problems. A program on communications presents a listening process in which a close friend or peer provides assessment feedback on the learner's effectiveness as a listener. In these programs, role playing and simulation are used extensively to permit learners to analyze real-world situations.

Supplemental Materials. Program guides that accompany computer-assisted learning programs feature operating instructions and statements of learning goals and program intent. The program guides include worksheets and other materials to support the learner's use of the computer and courseware. Printers are used to report the results of assessments and provide a tangible record of the learner's effectiveness. The worksheets included in the program guide must be clear and easy to use in order to facilitate the completion of related action exercises and action planning.

Conclusion

Community colleges will survive and flourish to the extent that they aggressively provide learning opportunities tailored to adult learners' preferred ways of learning. As adult learners engage the microcomputer as a vehicle for learning in increasingly large numbers, successful community colleges will provide ways of supporting adults in their compulsion to learn through this new technology.

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Microcomputers may be the essential link that enables education and business and industry to develop cooperative training programs at the job site that integrates training with work assignments.

The Use of Microcomputers in the Continuing Education of Community and Professional Constituencies

James E. Garmon

The appearance of inexpensive microcomputers on the market in the mid 1970s has enabled individual managers to buy them as they would any piece of office equipment. Micros have since become a common sight in the office, workplace, and home, much as did the hand-held calculators that preceded them. It has been estimated that nearly 80 percent of all jobs today involve some type of computer interaction. These developments make it clear that computers will become increasingly important for training purposes and that computer literacy will be seen as a critical employee skill. The low cost and high capability of microcomputers mean that computer-based training is now a possibility for any company that is interested. For many industries, the microcomputer may well be the long-sought answer to their training needs.

Computer-based training (CBT) has a broad and varied potential, according to a survey by Kearsley (1981) of training directors and managers in 160 corporations among the Fortune 500. Kearsley con-

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ducted the study to assess the scope of computer use in training and focused on five major areas: training applications, hardware, software, courseware, and number of students involved. Analysis of the data collected indicates that the use of computer-based training is becoming increasingly commonplace in business and industry and that technical skills and management training are the most common uses.

Training Applications

Technical Training. Peter Brown, a shipping clerk at Litton Industries, wanted to improve his job skills but found evening classes unbearable. "I just never function well in a college classroom," he said. Now, he arrives at work an hour and a half early three mornings a week in order to train for a technician's job. Peter doesn't train in a classroom setting. Instead he studies at a learning station, which is equipped with a microcomputer terminal, video monitor, specialized electronic testing equipment, tapes, and text materials. The learning station has been set up jointly by Litton and the College of San Mateo as part of an effort under California's Work Site Education and Training Act.

Peter needed very little formal instruction in use of the learning station. He received an orientation to the equipment and computer terminal, and then he was left on his own. If he encountered difficulties, he could request assistance from an instructor. Otherwise, Peter progressed at his own speed. According to Jim Petromelli, project director of the College of San Mateo, this scenario describes a typical student enrolled in its training project model. It also describes how training is integrated in the work environment. Students experience an instructional mix of published or specially written text and lab materials, along with commercial and specially modularized videotapes, integrated into a computer-managed delivery and testing system. Full college credit is awarded on completion of instructional units, to a maximum of eighteen semester credit hours, toward the associate in science degree. Several San Francisco Bay area companies are involved in this training program with the College of San Mateo, including Ampex, Litton Industries, Watkins-Johnson, and Hewlett-Packard. All directions for learning and interaction with the equipment and materials are provided by the microcomputer.

On a typical day, Peter types his password on the microcomputer keyboard and activates the lesson from the point where he left off the previous day. Each module begins with a videotaped lecture controlled from the computer keyboard, followed by a skill exercise coordinated by the computer program. Finally, Peter completes a multiple-choice examination and the computer records the results. Exams vary for each student, since the computer selects test questions at random and changes the order in which they appear to reduce the possibility of cheating. Test results are compiled on a floppy disk to which only the instructor has access.

The program at Litton uses Apple II and IIe computers. The courseware has been programmed in BASIC by professional community college staff who are experienced and highly qualified in the production of interactive instructional systems. The system includes a management program to track users' individual progress. Each user has a password, with which he or she signs on and gains access to the system. The password is the key to individual records and transcripts of progress. The programs will not allow students to advance in the learning modules until they have mastered the appropriate skills. The system is completely self-contained, and it can track up to fifteen students. Four modularized core courses make up the package: fundamentals of direct current, alternating current, semiconductors, and digital electronics. It will take Peter Brown between four and six months to complete the self-paced courses. A complete computer-managed instruction setup costs about $7,500 and includes an Apple II or IIe with dual disk drive, a color television receiver, a high-resolution black-and-white monitor, a half-inch videocassette recorder, and various pieces of electronic test equipment.

Although this scenario describes a fixed learning station within Peter's company, other variations are possible. In another arrangement, a mobile van brings the learning station directly to any one of several work sites to serve employees of different companies whose products involve microwave electronics. In-plant theory and training and related homework studies are supplemented with practical exercises in the van, which are conducted with the microprocessor-operated training station. Field instructors accompany the van to the work sites to observe student performance and assist learners with the hands-on portions of the lessons.

At Xerox Corporation, a prototype adaptive testing system is used to pretest students for basic sales training (Kearsley, 1981). Students complete their self-study preparation on microcomputers located in branch offices before they take sales training courses at a central training facility. A second project involves tutorial instruction for service representatives. It includes such subjects as service call management, machine installation procedures, technical updates, and reported field problems. A third application involves the training of retail store employees in how to demonstrate the equipment sold in Xerox stores.

Boeing Aerospace provides a course for technical staff in microcomputer fundamentals using the Commodore KIM and Intel 8080A kits. Radio Shack TRS-80s are used for programming instruction. Boeing encourages students to take portable terminals home for training purposes.

The Customer Service Division of Eastman Kodak Company uses Apple computers to provide service technicians with practice in equipment troubleshooting. Schematics of equipment are displayed on the screen, and a light pen becomes a soldering iron that the technician can use to repair or replace the faulty component. This kind of simulation provides a good deal of hands-on practice while avoiding the safety problems and costs associated with real equipment.

Management Training. Major applications for microcomputers in management training include sales training, administrative and clerical training, programming, and computer principles. The sales training program at Guaranty Mutual uses Radio Shack TRS-80s and software that provides simulated selling situations as well as account-tracking capabilities. The General Electric Executive Education Center has used microcomputers since 1981 as part of its management education program. Micros are used to store and report administrative data, solve basic financial problems, and help learners to understand busness concerns.

Simulation

The advent of the microprocessor has provided new dimensions for training in decision making. Its ability to simulate situations found in most industries is particularly useful. This capability allows those involved in training and management to focus on variables that relate to actual decisions made at all levels within the organization (Oscarson, 1982). One benefit of the microprocessor is that it allows the student to test or apply knowledge acquired in the classroom or industrial setting to practical decision making. The results of alternative decisions can be examined in simulations, which enables costly mistakes to be avoided. Of the instructional strategies employed with microprocessors, simulation is the most common (Kearsley, 1981).

Hardware

As Kearsley (1981) reported, the most popular hardware used in industry training includes the Apple II, the Radio Shack TRS-80, the IBM 5110, and the Micro PLATO. A number of custom-designed systems are also used. The Apple appears to be the most commonly used microcomputer. Whereas memory size is a major cost factor with large mainframes, microcomputers processing a 64K memory are more than adequate (a 64K memory holds up to 64,000 bits—about 8,000 eight-character words). The addition of floppy disk storage to a micro substantially expands its memory storage capacity.

Software and Courseware

The software and courseware used in industrial settings is developed within the companies themselves, as in the College of San Mateo model. BASIC is the most common language for these programs. The emergence of inexpensive microcomputers has generally made computing a fact of life for almost any business, but the high cost and long hours needed for the creation and testing of computer-based curricula remain formidable bariers to the widespread use of computers in training. It may still require as many as two hundred development hours to produce one presentation hour. Courseware development is likely to remain a major consideration in industry training, since most training materials must be custom-developed for a given company, and off-the-shelf items are not appropriate. One major problem that users of microcomputers in training must face involves their limited capability and memory size. As already noted, the most common strategy used in training is simulation, which requires considerable processing power and memory. Even greater capability will be required as the need for graphics and voice input output increases.

Cost Advantages

The advantage of the microcomputer as a training tool is economic. As a trainer, it costs less than the lowest-paid employee on staff. For less than the cost of one month's lease of a mainframe system, a small business can own a microcomputer. And, since these machines are designed for consumer use, just about anyone can learn to create and store programs for them. Faced by increasing need for training at the job site and by rising labor costs for traditional, live classroom instruction, the potential offered by microcomputers is plain.

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A practical approach to the time-consuming, frustrating search for a microcomputer system emphasizes the instructional situation in which it will be used.

Choosing a Microcomputer for Use as a Teaching Aid

Cheryl Visniesky
Joan Hocking

Computers can no longer be considered a fad, nor can they be ignored. Because they have become more compact, versatile, affordable, and easy to operate, they have spread into all areas, including education. As a result of the proliferation of affordable microcomputers, educators are facing a new age—the age of computer-assisted instruction. Computers make learning fun, and students who have been exposed to computers and computer games since elementary school, where computer-assisted instruction was first introduced, are eager to play with them. Although computer-assisted instruction makes learning easier for students, it does not necessarily make teaching easier. In fact, it increases the burden by requiring training and preparation. Why, then, are educators turning to it? The answer is threefold: It's exciting, it's here to stay, but, most important, it works—it helps students to learn.

The decision to use computer-assisted instruction opens the door to what could be a monumental task for the instructor who is a novice in the computer field. That task begins with the search for a microcomputer system that is uniquely suited to the instructional situ-

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ation in which it will be used. This chapter describes a practical approach to that time-consuming, frustrating search.

The first step in choosing a microcomputer is to think your project though. What do you want to accomplish? Why do you want a microcomputer? What will it do for your project that older, conventional equipment will not do? What pedagogical advantages will ensue from using the microcomputer? Will it really help you to teach better and students to learn more effectively?

When these general questions have been answered, it is time to become more specific. Three series of questions can serve as a guide. First, what specific applications will you and your campus make of the microcomputer? What courses will rely on it? Will it be used by a single department or course, or do you envision multidepartment or multicourse usage? The answers to these questions determine the general type of equipment that you should investigate. Knowing whether you want a microcomputer, minicomputer, or word processor narrows your options and makes your search easier.

Second, what do you want your microcomputer to do? Will it be used for drill and practice in support of basic instruction, will it be used for regular classroom instruction, or will it be used for more innovative applications? A related consideration is whether it will be used only by the instructor for demonstrations in the classroom, by individual students, or by small groups of students. The answers to these questions determine how sophisticated a system you require and tell you how much and what kind of peripheral equipment you will need. For example, if you decide on drill and practice for individuals, you will need several work stations (terminals and small monitors), but you may not need a printer. Classroom usage requires only one terminal but several large monitors. Any usage demanding hard copy—such as faculty research or some innovative approaches—necessitates a printer. Printers vary in size, quality, and price. A letter-quality printer represents about half the cost of an entire microcomputer system, so you should consider whether a less expensive dot matrix printer will meet your needs.

Third, what capabilities do you want in a microcomputer? The answer to this question, coupled with the requirements defined in response to the first two series of questions, will complete your list of microcomputer needs, give you a reasonable overview of the system that you can present to administrators and use in your grant search, and enable you to estimate the funding needed. Here are some of the capabilities that should concern you: Do you need to link individual pieces of the system—for example, several monitors together or several terminals to one printer? How interactive does your system need to be?

That is, how much prompting and feedback will users require? Do you want to program the computer yourself, or will you be relying on existing software? Finally, do you wish to link your microcomputer to the mainframe at your institution? Answers to these questions will rule out some systems and thereby make your search more manageable.

Once you have defined what you want your microcomputer to do and decided in general what equipment you will require, it is time to gain administrative support and actively pursue funding possibilities. Before approaching anyone, write up a one-page proposal of your project, and list your equipment needs. Seek the support—both moral and financial—of your immediate superior. Try to elicit his or her cooperation by having sound reasons for embarking on your project. Ask for advice on preparing a funding proposal, and encourage him or her to recommend other administrators who make equipment decisions and control funds. Follow up on his or her suggestions, and get the names of other key people from each person with whom you confer. Ask each about available scholarly or research funds for which you might apply, grants they know about, and places in the budget where your project might qualify for funding. Contact the grant office of your institution, and ask its staff to search all possible funding sources for you and put you on the mailing list for source updates. Don't overlook such obvious sources as gifts to the university, alumni offices, and lists of companies that might be willing to sponsor your research. Sometimes, the computer company from which you buy will be interested in underwriting some of your investigation. Finally, look at the possibility of combining your project with that of someone else on the faculty. Microcomputers are expensive, and showing administrators that they will have maximum usage is a plus.

Once your grant search is underway, the next logical step is to form a search committee. Ideally, everyone who plans to use the equipment should be on the committee. However, if this group is large, arranging demonstrations that can accommodate everyone's schedule may prove impossible—or at least chaotic. If the group is large and several uses are planned for the computer, each interest group should be represented on the committee. If potential users are not computerwise, a person who is knowledgeable in the field is essential to the committee. A computer person from your campus would be a logical choice, provided that he or she is interested and willing. Without such a person, you will frequently discover, after a vendor has left, questions that you should have asked but did not in your ignorance. Your expert will think of many such questions.

Your search committee should become as well informed as possible. You will find three valuable sources of information: The first source is people who are already using microcomputers. Those who have been through the selection process will be willing to help, and they will offer many good tips. Instructors in your field who are already using computer-assisted instruction will be the most helpful. Ask particularly about problems with student usage and equipment breakdown. You will find that some equipment has a reputation for being tough, other equipment for being fragile, and so on. The second source is experts in your computer center. They know the right questions to ask, they have contacts with computer people who may be of assistance to you, and they are familiar with computer companies. The third source is literature on the topic. Again, your computer people can offer guidance and recommend journals for people interested in computer-assisted instruction.

Your reading, questions-and-answer sessions with other instructors, and contacts with computer experts will result in a list of equipment that you can consider. Use this list to arrange for demonstrations from vendors. Their names and addresses will be available through your computer center as well as in ads, promotional literature, and the yellow pages. Prepare for these demonstrations by listing the questions that you will want to ask. For example, can the equipment be linked with a mainframe or other equipment, such as typewriters or monitors? Is the equipment programmable? What software is compatible with the equipment, and how available is it? How much memory is available on the microcomputer? How much does the equipment cost? (The quoted price may not include everything that you need for your application, such as cables, modems, couplers, even disk drives, which may be priced separately. In most cases, software is priced separately, and in some cases, it is rented. Be sure to ask about the hidden costs.) Is service available? How far away is it, and how long does it take to get it? What does the warranty cover? How long does it last? If the machinery breaks down, must you crate it up, send it off somewhere, and thus be without it for what may be an extended period of time, or will it be serviced on the site? Are replacement equipment or parts readily available? Is training available? Is it free? Where and when is it available? Who provides it? For how many? How long will it be until the equipment is delivered? Strangely, time becomes very important after the decision has been made. You will also want to inquire about the method of delivery and whether the vendor sets up the equipment for you. This shopping process is very time-consuming, so allow plenty of time for it.

By the time you have seen several microcomputer demonstrations and determined which systems suit your needs, information on funding sources should have accumulated. Try to match your needs and desires with sources that seem most likely to support your type of project. Gather proposal forms together, and get ready to work out the final details. Most important, check on how much money is likely to be forthcoming, as this will be a major factor in your equipment decisions.

You are now ready to make a final decision on your microcomputer system. Compare all the systems that you have seen with the needs on your list, and choose the system that is ideal for your institution. Now, look at the funds available. If they match the cost of your ideal, bravo! If not, you must compromise. Start by determining what you can do without or which items can be of lower quality. These decisions are difficult, and they take time, especially if more than one person is involved. But, stick with it until everyone is satisfied. A system that doesn't suit your needs is a great source of frustration. A system that does is sheer joy.

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Can we predict the future of community colleges by examining colleges now on the leading edge and certain bellwethers in education?

The Future of Microcomputers in Community Colleges

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William L. Ballenger

Where might we be in five or ten years with respect to microelectronic technology in community colleges? In speculating on the future of community colleges, Cohen (1976, p. 42) states that "events move slowly in educational institutions, and the community colleges of the year 2000 will not be much different than those of today." His vision can be contrasted with that of Campbell (1983), who calls on faculty to assume leadership in using their microcomputers to form network user clubs for which they are the primary mentors and resource persons for their disciplines in the community. Whose crystal ball do we believe?

Recent research supports both prognosticators, depending on the sample. Bender and Conrad (1984) have developed a continuum of colleges in relationship to their use of microcomputing and constructed three typical profiles: fledgling, apprentice, and sophisticate. Each institution seems to progress through distinct stages as it becomes increasingly sophisticated in using the new forms of technology now available. Fledgling and apprentice colleges can view an

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approximation of their future now. According to the authors, the sophisticate college "demonstrates an advanced. . . level of development and applications of the microcomputer in all facets of the institutional endeavor... sees the new technology as equally central to the operation, services, and requirements of colleges... they would see the importance of the telephone... recognize the lag between education and the private business sector in the application of computers. . . seek ways to profit from the advances within the business sector and maintain an ongoing effort to make decisions which meet present requirements while being contributory to subsequent subsystems, services, or requirements... reported long-range development plans for computing and policies that define the college's role in computer literacy of both employed and students... and integrating their computing and communications capability in such areas as local area networks, micro-to-mainframe comunications, and access to off-campus data base resources." These authors found that a very small segment of their national survey warranted the sophisticate classification. However, they did find a series of positive trends indicating that colleges are moving quickly toward more advanced stages of microcomputing.

To what extent will sophisticate colleges be using the microcomputer five to ten years from now? In exploring the question of the future of microcomputers in community colleges we will examine, first, the evolving mission of colleges in the context of the new information society; second, strategic decisions and modes of response to serving their constituencies; third, certain bellwethers that forecast stages of adaptation of new technology; and, fourth, the future directions and choices facing community college leaders.

Interpreting the Mission

A panel of sixteen of the world's leading futurists predicted at the close of the World Future Society's fourth general assembly in July 1983 that by the year 2000 about one third of the work force in industrialized countries will be teleworking — that is, using telecommunications to link themselves with central work sites — while half of all managers and executives will be using electronic workstations themselves ("Work in the Information Society," 1983, p. 35)

The extent to which microcomputers are actually used will depend in large part on how college leadership translates the college mission into working policies and procedures that can service communities. The mission of community colleges has evolved over their short history in response to various societal factors. The mission of community colleges is best characterized today by the American Association of Community and Junior Colleges theme, Opportunity with Excellence. First, the institutions are recognized as accessible open-door colleges providing comprehensive programs for any adult who can profit from instruction. Second, the institutions' occupational programs are increasingly looked on as a national resource that can train and retrain adults in technical skills needed in the work force. At the same time, other service providers are attempting to be responsive to market shifts and to serve the same populations. The challenge for leaders will be to interpret the community college mission and continue to serve their constituencies in the context of rapid social and technological change, which rapid advances in microprocessor technology are in large part creating. Strategic decisions face leadership's interpretation of mission in terms not only of the open-door philosophy but of the manner in which occupational programs are delivered to the community.

Strategic Decisions and Modes of Response

Consider again the implications of the World Future Society's prediction that more than one third of the work force in industrialized nations will be teleworking in the year 2000. Access and opportunity have been cornerstones of community college philosophy. As leaders, how do we extend access to those who cannot afford their own personal computer in a telecommunications information society? Colleges must thoroughly examine the issues and modify existing policies and procedures where needed to continue to be responsive to their public. Their commitment to the open door will continue to set them apart from other service providers. A similar commitment to serving the needs of business and industry can approximate several models.

Recent research by the National Center for Research in Vocational Education (NCRVE) (Faddis and others, 1982) provides another framework from which to consider the future of microcomputers in serving occupational education components of the community college mission. The NCRVE's Technology Adaptation Project, which sought to determine how colleges were responding to users' needs for skilled manpower in areas of new technology, classified institutions on a continuum of three profiles: early, fast-follow, and delayed. At issue was the timing of two-year college training programs to meet the need for new skills and knowledge that emerge as users and producers translate new technology into jobs. Three factors can affect the timeliness, effectiveness, and long-term success of programs developed under the fast-follow response mode: the nature and adoption rate of the technology in local or regional business and industry sectors; the level of planning cooperation and resource sharing among government agencies, educational institutions, and business and industry groups; and the existence of flexible institutional capabilities essential to the rapid development, delivery, and maintenance of courses and programs in high technology fields. The NCRVE classification that comes closest to Bender and Conrad's (1984) sophisticate (which admittedly is five years behind industry) is fast-follow. Here, the process initiates and supports technology transfer, and, although the number of qualified instructors is limited, the employment demand is expanding. The community college leader is faced with determining what is the appropriate technology for serving the manpower needs of local business and industry. Consider our focus on the future of the microcomputer and ask two questions. How many new users (individual firms) acquire (lease or purchase) new micros within a given period of time (month or year)? Are the new micros supplemental, or do they replace minis or mainframes?

One of us faced just such a decision in the late 1970s as instructional dean of a small rural college serving an agricultural community. The Radio Shack TRS-80 was just beginning to make an impact on the marketplace. The college was considering the focus of its new data processing curriculum. A third-generation mainframe computer, the IBM 360, had just begun to be used through time-sharing to serve the local farming cooperative. In order to avoid training for obsolescence, the curriculum needed to be broad-based and to encompass micros. However, the existing computer technology dictated that employment opportunities in the area were in the long term obsolete but in the short term appropriate. The extent to which microcomputers will play a prominent role in the future of community colleges will also reflect the appropriateness of such technology to the needs of business and industry in the respective community.

Bellwethers

Education in general has its trendsetters, which signal future directions for our institutions. Naisbitt (1982) used trend analysis to identify certain bellwether states, where most of the social invention in America occurs. Community colleges can look to three bellwethers in forecasting future trends: industry in-house training programs, the military, and colleges in the League for Innovation. We will take a brief look at each bellwether in considering the future of the microcomputer.

The first and foremost bellwether for community colleges is industry's own in-house training efforts. How are the firms that produce microcomputers using them? The Educational Services Department of Digital Equipment Corporation reports that "new technologies, such as computer-assisted instruction coupled with an interactive videodisc, can be used to deliver quality instruction cost-effectively at a large number of widely dispersed sites, even if only one person needs to be trained at each site. These technologies also allow us to provide decentralized training that is appropriate for widely diversified student audiences... recent developments in both hardware and software have now made artificial intelligence (AI) practical as an instructional tool on some microcomputers" (Heines and others, 1983, pp. 102, 108).

The second bellwether for education is the military, which possesses the largest system of technical education in the world. In 1977, one of us was a staff member of the Community College of the Air Force and had the opportunity of delivering a keynote address to the American Technical Education Association on the topic of the technical teacher for our third century. Reviewing that address in preparation for this chapter, he found that his prognostications had drawn heavily on the Air Training Command's long-range fifteen-year plan. Practically every one of his predictions has become fact, although the fifteen-year planning cycle is only halfway through. Computer applications for training are referred to repeatedly in the fifteen-year plan. The forecast that self-paced individualized instruction would be used in all applicable situations (Campbell, 1977) is particularly germane to the present discussion. The report is indicative of the important role that microcomputers will play in future instructional programs. Unfortunately, we cannot see the Air Training Command's vision of training past 1991, because its largest long-range plan is classified.

The third bellwether is the colleges in the League for Innovation. The League is composed primarily of larger district colleges across the nation, which pool their resources on consortium projects of common interest. As early as 1972, the League worked with IBM over a five-year period to design and conduct special workshops for member institutions on what we today call *computer literacy*. This fall, the League's eleventh national conference will address the issue of community colleges and the computer. League members will dialogue with four or five major computer corporations to facilitate the design and development of software that meets the needs of community colleges (O'Banion, 1984). It is highly probable that the majority of League colleges can be classified as apprentice under Bender and Conrad's (1984) scale.

Future Directions

Given the trends indicated by the bellwethers in education and the stages of development of microcomputers in the nation's community colleges, what can we prognosticate for future directions? Ultimately, the extent to which the potential of the microcomputer is realized will be defined by the community colleges' users or clients—business and industry and adults desiring opportunities for training and retraining—and by the vision of community college leaders in interpreting the applicability of microcomputers to fulfilling the colleges' mission.

Programs to serve business and industry will increasingly be designed around job specifications. The technology of interactive videodiscs will enable curriculum designers to rely increasingly on simulations, particularly in high-cost training areas. The military and commercial airlines have used this approach effectively for years in their flight simulation schools.

Computer networks will enable training to be decentralized and to combine teleworking and telelearning capability in the home. At the same time, production and certification centers that specialize in the development of software and curriculum in high-cost program areas will emerge. Adults will eventually demonstrate their acquired knowledge and skills on the latest technological equipment in order to complete program requirements successfully.

Programs to provide training and retraining opportunities at accessible times for adults will also have the capacity for teleworking and telelearning in the home. As hardware costs drop dramatically, adults will be able to borrow a micro and videodisc from the learning resource center to use at home for personal study, as we do today with library books. The emphasis in colleges will shift from hardware acquisition to software development. Networks or bellwethers, such as the League for Innovation, will be in the forefront of these initiatives. Extensive advances in this area will be limited by the high cost of accessing telephone and information networks until a realistic funding mechanism emerges.

Asking the right questions will be central to effective leadership in the future. Leaders will focus increasingly on the what ifs in order to use their information system to improve their decision making. The one-page executive memo will give way to the one-page videotext, which leaders will view at their own workstation. Artificial intelligence or smart computers will have the capacity to propose solutions to common administrative and instructional problems. But, tomorrow's managers will not trust their destiny to machines but will use them for information analysis, reduction, and display. All things being equal, intuition will continue to play a dominant role in decision making by providing the vision necessary to chart the future of the community college movement.

In order for the full potential of the microcomputer to be realized, existing patterns of finance and governance will need to be reexamined. According to Cleveland (1982), Peter Drucker maintains that since information is now our principal resource and since it is so different in character from the "things" that were our principal resource in the past, it is a mistake to use the same concepts and assumptions to manage information. Our policies and procedures regarding faculty loads, class size, funding, and support services will need to be reexamined from an information systems perspective. The American Association of Community and Junior Colleges is urged to form a nationwide task force to propose new policy frameworks that will allow colleges to remain responsive to the future needs of their constituencies. In that context, the microcomputer will play a prominent role in the future of the community college movement.

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Further resources from the ERIC system provide additional information on instructional and other applications of microcomputers at the postsecondary level.

Sources and Information: Microcomputers

Jim Palmer

This chapter surveys recent Educational Resources Information Center (ERIC) documents and journal articles that deal with instructional and other applications of microcomputers at the postsecondary level. The resources described here were selected from the results of a computer search of the ERIC data base. The annotations synopsize the abstracts provided in ERIC's *Current Index to Journals in Education* and *Resources in Education*.

While a great deal is being written about the uses of microcomputers in education, most of the literature is targeted toward practitioners at the elementary and secondary levels. This is unfortunate, because microcomputers have long been used for instructional and administrative purposes in the nation's two-year colleges. While the demand for information on microcomputers has skyrocketed, librarians have been hard-pressed to meet this demand with the literature available.

The resources described here are divided into two groups: instructional applications and miscellaneous applications and administrative considerations. The full text of the ERIC documents (items marked with an ED number) can be ordered from the ERIC Document Reproduction Service (EDRS), or they can be viewed on microfiche at more than 700

D. A. Dellow, L. H. Poole (Eds.). *Microcomputer Applications in Administration and Instruction*. New Directions for Community Colleges, no. 47. San Francisco: Jossey-Bass, September 1984.

libraries across the country. For an EDRS order form, a list of libraries in your state that have an ERIC microfiche collection, or both, write to the ERIC Clearinghouse for Junior Colleges, 8118 Math Sciences Building, University of California, Los Angeles, California 90024. Journal articles (items not marked with an ED number) are not available from EDRS or in ERIC microfiche collections, and they must be obtained through regular library channels.

Instructional Applications

Anandam, K., and Kelly, D. *GEM—Guided Exposure to Microcomputers: An Interactive Video Program.* Miami: Miami-Dade Commuunity College, 1981. 12 pp (ED 205 238).

Describes a computer program designed to familiarize faculty with microcomputers and with the potential of interactive video programming, which allows the instructor to block a video program into segments and insert textual instructions, questions, or explanations where needed. The program requires the use of an Apple II + microcomputer, a television set, an ETS 2000 Interactive Video Interface for Betamax with accompanying course-written software, and a Sony Betamax video player.

Bak, P. "Doing Physics with Microcomputers." *Physics Today,* 1983, *36* (12), 25–28.

Examines the use of microcomputers in performing large-scale physics calculations at speeds comparable to those of full-scale computers. The examples provided include a Monte Carlo simulation of the three dimensional Ising model and a program for the Apple computer that uses the time-independent Schrodinger Equation.

Dellow, D., and Ross, S. M. "Microcomputers: Compact Model of the Future?" *Community College Social Science Journal,* 1982–1983, *4* (3), 72–75.

Discusses the educational uses of microcomputers and their implications for social sciences. Sees microcomputers as helpful in conducting research, in simulating the attributes and characteristics of real-life situations without real-life risks, and in computer-assisted instruction.

Dimsdale, J. M. (Ed.). *A Guide to Microcomputer Programs in the California Community Colleges.* Costa Mesa, Calif.: Orange Coast College, 1982. 59 pp. (ED 231 408).

Provides abstracts for eighty-nine teacher-developed microcomputer programs that can be obtained for noncommercial use. Each abstract contains information about the program's title and author, the author's institution, the computer for which the program was written, the programming language used, the peripherals needed, the program's content, and how the program can be obtained.

Fincke, M. S., and Wakefield, L. "Archaeologists Dig Computers." *Community and Junior College Journal*, 1983, *53* (8), 36–37.

Describes the use of electronic measuring devices, hand-held computers, and microcomputers by archaeologists at Pima Community College to compile data. Deems electronic compilation of data more accurate than traditional static collection methods.

Gamble, A. "BEADS: A Realistic Approach to Elementary Statistics." *Journal of Computers in Mathematics and Science Teaching*, 1983, *3* (1), 22–24.

Describes a program used to simulate sampling from a binomial distribution. Illustrations from the program are included.

Goodridge, F. "The Teaching of Protein Synthesis: A Microcomputer-Based Method." *Journal of Biological Education*, 1983, *17* (3), 222–224.

Details two computer programs for teaching protein synthesis. The first is an interactive test of base-pairing knowledge, and the second generates random DNA nucleotide sequences; instructions for substitution, insertion, and deletion are printed out for each student.

Henney, M. "The Effect of All-Capital Versus Regular Mixed Print, as Presented on a Computer Screen, on Reading Rate and Accuracy." *AEDS Journal*, 1983, *16* (4), 205–217.

Reviews research conducted to assess the effects of all-capital text on reading rate and accuracy. Concludes that, while college students read mixed print (upper and lower case) faster, they read all capitals (upper case only) more accurately.

Homer, M. M. *Business Use of Small Computers in the Salt Lake City, Utah, Area.* Salt Lake City: Utah Technical College, 1981. 45 pp. (ED 222 231).

Outlines methodology and findings of a survey conducted to gather information for the development of a curriculum integrating computer applications with business course instruction. The survey, targeted toward businesses in the Salt Lake City area, sought to determine the status and usage of microcomputers, future data processing acquisition plans, and the perceived importance of applied data processing instruction in business courses.

Huggins, D. L., and Myers, R. E. "Microcomputer-Simulated CAD for Engineering Graphics." *CoEd,* 1983, *3* (6), 10–13.

Details a simulated computer-aided graphics program at the Pennsylvania State University. Considers the program rationale, facilities, microcomputer equipment (Apple), and development of a software package for simulating applied engineering graphics.

Jurden, D. A. "Computers for Clio? Historian Asks." *Community and Junior College Journal,* 1983, *53* (8), 38–39, 58.

Relates experiences in using computers and microcomputers in the teaching of history. Reviews the value of computers in testing, record keeping, reporting, and advising. Cites benefits for instructors and students.

Kamm, S. D. *Microcomputer Tutorial Assistance Project.* Oklahoma City: South Oklahoma City Junior College, 1981. 29 pp. (ED 200 284).

Summarizes the objectives, costs, and outcomes of a project undertaken by South Oklahoma City Junior College to develop fifty computer-based tutorial lessons to assist students in mastering the requirements of a competence-based physics course. Describes special features of the tutorial lessons, which are programmed on microcomputer cassettes and which require students to establish problem-solving methodologies with gradually decreasing amounts of assistance.

Kelley, J. C. "Discovery Learning in Trigonometry Using Microcomputers." Paper presented at the annual meeting of the American Mathematical Association of Two-Year Colleges, Washington, D.C., October 1980. 104 pp. (ED 201 346).

Describes six computer-assisted discovery learning trigonometry units, which supplement regular classroom instruction and which are completed at the college math lab on Apple II computers. Problem sets for each unit and samples of computer-produced graphs and instructions for selected problems are appended.

Levin, R., and Doyle, C. "The Microcomputer in the Writing/Reading/Study Lab." *Technological Horizons in Education,* 1983, *10* (4), 77–79, 100.

Discusses advantages of computer-assisted instruction (CAI) in a community college writing-reading curriculum. Outlines problems to be avoided in establishing a CAI verbal skills lab.

McDannold, T. A. "Instructional Use of the Microcomputer: Personal Experiences." Unpublished paper, 1983. 21 pp. (ED 235 798).

Discusses computer-assisted instruction (CAI) and computer-managed instruction (CMI) at the community college level. Examines eight CAI and CMI applications and provides a list of courseware review sources and an outline of earth science courseware.

Michael, J. A. "Computers in Physiology Teaching: How Can APS Help?" *Physiologist,* 1983, *26* (5), 323–325.

Examines the use of computer-based education (CBE) materials in physiology on the basis of a brief survey of physiology chairpersons ($N = 117$). Indicates the most popular use of CBE materials is for simulation of physiological systems.

Orr, W. T., Jr. "Committed to Computers." *Florida Vocational Journal,* 1982, *7* (4), 8–16.

Describes the use of microcomputers in the teaching of electronics technology at a Florida community college and details the Individualized Manpower Training System at a comprehensive high school aimed at academically disadvantaged students.

Patterson, B. "Evaluating Microcomputer Software for a Community College Reading/Writing Center." Paper presented at the meeting of the Western College Reading and Learning Association, Portland, Ore., March 1983. 11 pp. (ED 233 691).

Presents a detailed list of general guidelines for evaluating reading and writing computer software. Organizes the guidelines under three categories: educational soundness of software, ability of software to utilize microcomputer capability, and validity of software for educational, as opposed to personal, use.

Smith, R. L. "Bibliography: Computers in Physics." *Journal of Computer in Mathematics and Science Teaching,* 1983, *3* (1), 49–50.

Provides an annotated bibliography of twenty items on the use of computers in physics instruction.

Tross, G., and Di Stefano, M. F. "Interactive Video at Miami-Dade Community College." Unpublished paper, 1983, 10 pp. (ED 230 256).

Describes interactive video (an instructional system that allows the computer to control the playing of segments of a videotape or videodisc) and outlines the steps in developing an interactive video program. Reviews specific applications at Miami-Dade Community College.

Visniesky, C., and Hocking, J. "Choosing a Microcomputer for Use as a Teaching Aid." Paper presented at the annual conference of the

Pennsylvania Association of Two-Year Colleges, Carlisle, Pa., April 1982. 8 pp. (ED 214 608).

Outlines steps to be followed in selecting a microcomputer for instructional purposes: determining the types of courses in which the computer will be applied, identifying desired capabilities, gaining administrative support and funding, convening a search committee to gather information abut existing systems, and arranging system demonstrations by vendors.

Miscellaneous Applications and Administrative Considerations

Admire, J. N. "Everybody Profits from Shared Computers." *Community Junior Journal*, 1983, *58* (8), 40–41.

Describes a project that provided for the joint purchase and use of 150 microcomputers by Lake Land Community College (Illinois) and fifteen area public school districts. Reviews benefit in enrollment gains, decreased initial purchase costs, teaching opportunities, and increased educational benefits for students.

Brown, K. C. *The Administrator's Use of Microcomputer Systems*. Washington, D.C.: American Association of University Administrators and ERIC Clearinghouse on Higher Education, 1983, 8 pp. (ED 234 729).

Discusses the use of microcomputers by administrators to increase productivity. Briefly examines three types of decision support aids for microcomputers: electronic worksheets, graph and chart formatting aids, and data base management systems. A bibliography is appended.

Chemeketa Community College. *Chemeketa Community College Developmental Education Enrollment Record Keeping System*. Salem, Ore.: Chemeketa Community College, 1981. 36 pp. (ED 217 829).

Describes a record keeping system written in BASIC for use on the Apple II + microcomputer with 48K memory and two disk drives with DOS 3.2. Explains the menu options, print options, and a special menu for English-as-a-second-language students.

Division of Community Junior Colleges. *Computer Survey of Florida Community Colleges*. Tallahassee: Division of Community Junior Colleges, Florida State Department of Education, 1982. 26 pp. (ED 220 147).

Reviews methodology and findings of a survey of the Florida community college system conducted to obtain college evaluations of their own administrative software. Identifies colleges that have applied micro-

computer software to the analysis of financial, personal, facilities, library, student/course, and miscellaneous data.

Moore, R., and others. *Exploration of Career Information Delivery Systems via Computerization*. Richlands: Southwest Virginia Community College, 1981. 40 pp. (ED 203 910).

Presents information on seven computerized information systems: locally developed data bases on microcomputers, the Coordinated Occupational Information Network (COIN), the Computerized Vocational Information System (CVIS), the DISCOVER II program for microcomputers, the Computerized Educational and Career Information Link (CECIL), the Guidance Information System (GIS), and the System for Interactive Guidance and Information (SIGI). Compares these systems in terms of cost and information organization.

Poole, L. H., and others. "Computer Literacy: The New Mandate for General Education in the 80s." Published paper, 1982. 12 pp. (ED 214 610).

Discusses the potential educational uses of computers and considers the role of computer technology and technological literacy in higher education. Outlines the advantages realized by North Country Community College (New York) from the acquisition of computer resources and outlines the college's computer laboratory.

Sherron, G. T., and Gattone, D. R. "Selecting a Computerized Library Information System." *Cause Effect*, 1983, *6* (6), 18–23.

Outlines procedures followed by the University of Maryland in selecting a computerized library information system from among several turnkey on line circulation systems.

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From the Editors' Notes

The primary purpose of this volume of New Directions for Community Colleges *is to identify the challenges faced by community college educators as they attempt to implement the new microcomputer technology. There is a strong sense of pioneering spirit in this field, where there are no long-term experts. The instructors or administrators who want to learn about using microcomputers in their field have very little literature on which to rely. Reading a few short articles, attending a few convention presentations, and having the courage to give it a try are the hallmarks of the initiated. That is the spirit in which the authors of this volume share their experiences with the new technology.*