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Microcomputers: Where did they come from? What will we do with them?

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by Fred A. Teague and Doug Rogers

"New information technologies—computers, microprocessors, video recording devices and inexpensive means of storing and transmitting information—are creating a revolution as important as the invention of printing" (Melmed, 1982). Throughout the history of education, several technologies have developed which have had potential for major changes in educational practice. With the possible exception of the printing press, technologically derived educational changes have been minimal. In recent decades both programmed instruction and television have been viewed frequently as technological systems with great educational promise; however, these and other exciting technologies have generally not yielded the often anticipated benefits.

As a result, many educators are leery of a new technology heralded as a panacea for educational ills. Some may tend to write off the new microcomputer technology as an instructional toy that will shortly lose its novelty or as a gimmick that students and teachers will soon reject in favor of the familiar approaches.

However, the newer electronic technologies, especially microcomputers, will not fall by the wayside in our schools. The United States has become an information society and computers are rapidly becoming the national lifeline. They are essential to sustaining the quality of life that Americans now enjoy. Computers will not pass from the scene, either in society or in our schools. The microcomputer revolution is upon us!

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The very first "kit" versions of the microcomputer appeared in the early 1970s (Evans, 1979) and sales of these devices are increasing at a rate of 50 percent to 60 percent a year (Taylor, 1981). The classroom has not escaped the revolution. In 1980, a scant nine years after the first microcomputers were available, it was estimated that 90 percent of U.S. secondary and elementary schools incorporated computers for instructional and/or administrative purposes (Chambers and Bork, 1980). The implications of the microcomputer revolution for educators are many (Splittgerber, 1979). An exploration of these implications requires reflection on the revolution's origin and infiltration into the school to provide a more secure vantage point.

Microcomputers are actually the third generation of computers (Blair, 1982). First generation computers (1943-46) were enormous webs of mechanical relays and vacuum tubes. The size of a small building, they generated tremendous amounts of heat, required enough electricity to run a small city and were primarily limited to advanced mathematical calculations only. For these very reasons, the first generration was doomed to early extinction (Evans, 1979).

By 1950, major corporations (IBM, Bell Telephone, Speery-Rand) were funding development of the computer. The impetus for the evolutionary step into the second generation of computers came from Bell Telephone laboratories through the invention of the transistor. Replacing the bulky mechanical relays and vacuum tubes, the transistor allowed for the incorporation of expanded computer memory and for a vast reduction in size. The electronic nature of the transistor, as opposed to the mechanical nature of relays and vacuum tubes, substantially increased the already remarkable speed of the computer while expanding its versatility. The transistor, in essence, became the seed of the third generation. Nurtured by the militaristic and space exploration demands of the 1960s, computer development flourished. Development concentrated on the organization and miniaturization of transistor circuits. The concepts of "integrated circuits" and "large scale integration" combined these processes and made it possible to place 100,000 switching units on a "chip" of silicon about a centimeter square. Creation of this "microchip" or "microprocessor" gave birth to the microcomputer, the third generation of computers ((Blair, 1982; Eadie, 1982; Poirot, 1980).

If the microcomputer is only 10 years old, how did it infiltrate the classroom so quickly? One must realize that schools were using computer technology before the rise of microcomputers. Through purchasing a "port" (a connection or access point for a computer) or through a "time-sharing" arrangement (payment based on amount of computer time used), public schools gained access to mainframe computers at larger institutions, usually colleges or universities. The first applications were primarily administrative. Student scheduling, grade reporting, attendance record-keeping, and even college selection and occupational "counseling" (such as SIGI-System of Interactive Guidance and Information) were provided on these systems (Joiner and others, 1980). But the decreasing cost and the increasing capabilities of the microcomputer soon lured the educational system away from this type of arrangement (Poirot, 1980).

The microcomputer first stormed the classroom in the mid to late 1970s. B.F. Skinner's theories about learning, very popular during the 60s, led to the development of programmed texts, which now seemed especially suited for computer application. Experimental programs were conducted using mainframe computers, but the introduction of the microcomputer placed the cost of computer technology at a level where virtually all school districts could afford its use (Poirot, 1980).

The capacity of the computer to present information, permit student response, record and evaluate that response, reward or remediate, and record the student's progress made it the most versatile and complete "teaching machine" to date. Programs of this type are generally referred to as CAI—Computer Assisted Instruction.

Three branches of CAI have developed (Hallworth and Brebner, 1980). "Drill and practice" programs were the initial step into the classroom. Still the most heavily used type of CAI programs, "drill and practice" programs present repetitious applications of previously learned information; the primary purpose is to provide monitored practice and reinforcement of such skills as multiplication and addition, verb conjugation, and word or shape recognition. The second branch incorporates more of the microcomputer's potential. "Tutorials" present new information previously unknown to the student. Programs of this type are designed to provide sufficient practice for mastering the new concept or skill (Joiner and others, 1982). The third branch of CAI developed later and will be discussed later in this article.

A concurrent theoretical concept developed but not extensively practiced is CMI—Computer Managed Instruction. As the name implies, CMI is primarily a management tool. The computer's management capabilities include but are not limited to test generation, student pretesting, evaluation of a student's in-course progress, analysis of student's personal data, assignment of study activities or resources based on student's personal records and performance on test instruments and maintenance of complete records (Joiner and others, 1982; Leiblum, 1982).

Two major problems have hindered the widespread application of CMI. Software capable of manipulating and integrating the data bases necessary for CMI applications was designed for larger capacity computers. Versions currently available, such as Comprehensive Achievement Monitoring (Apple II), are limited to one aspect of the overall system or are poorly designed (Osborne and Bunnell, 1982). The reciprocal problem is that the current popular arrangement of floppy disk drives is inadequate for such software. The necessary memory for fully integrated programs is more likely to be provided by the small hard disk units (Memorex-101 8"—10 megabytes), which are considerably more expensive (Joiner and others, 1982).

The potential of the microcomputer, through CAI and CMI, to deliver a variety of programs at a variety of levels to a variety of students, seemed to be the instructor's answer to individualized instruction. Several elements still impede progress in this area. Though the cost of microcomputers continues to decline, the initial capital outlay to provide enough computers for even a relatively small number of students is still prohibitive. Likewise, the incompatibility of various brands of both hardware and software forces the purchaser to limit program selection to what is available for a particular system, to purchase a number of different systems, or to develop his/her own software, all of which are "costly" alternatives. Criticism of the "quality" of available software still proliferates (Blascke, 1979) and resistant faculty attitudes (Joiner and others, 1982) prevent extensive use of CAI. In spite of these issues, where CAI is being utilized on a large scale, improvement in student achievement and attitude towards learning has been good (Chambers and Bork, 1980).

No longer can instruction be viewed as a teacher and a group of students working in isolation. Experiences with CAI stress the importance of team approaches to the development of teaching programs. Authoring teams provided the means by which the large volume of PLATO materials could be developed, tested and implemented on a major scale. Staff development activities that provide basic microcomputer competencies for teachers who return to a totally traditional educational environment will likely not yield significant change. Instructional leadership which coordinates meaningfully the expertise and contributions of teachers, curriculum specialists, instructional technologists and evaluation specialists is necessary to achieve the changes required to derive lasting benefit from the new microcomputer technology.

As mentioned earlier, the initial number of microcomputers was generally small; therefore, access to these units was generally limited to two specific audiences—special education students and gifted students. Through these applications, the microcomputer established another beachhead. Computer programs using micros have been developed to aid the hearing, speech, motor and visually impaired. Talking computers are already available for the blind, while computer recognition of speech is rapidly improving the environmental control of the severely handicapped person (Joiner and others, 1982). The single-user nature of the microcomputer adapts especially well to meeting the variety of needs presented by exceptional children.

The second audience, gifted and talented students, makes extensive use of the third branch of CAI. "Simulations," based on the computer's problem solving capabilities, present the learner with situations requiring decision making, the results of which are projected, analyzed and reported to the student for continued alteration and manipulation. Students can run programs that control environmental, economic, socio-political and industrial models (Joiner and others, 1982). "Lemonade-Stand" (Apple) allows students to manage a mini-business controlling overhead, production, sales, etc.; "Geology Search" (McGraw-Hill) allows students to search for oil in a new continent, simulating geological tests; "CIVILWAR" is based on the strategies of 14 Civil War battles (Frederick, 1980).

The next wave of the microcomputer invasion was based on these same problem solving capabilities of the microcomputer. If students were to use the computer to experiment with various problem solving techniques and strategies, they had to be able to manipulate the computer's "intelligence." The need for instruction in computer programming was created. As modules and courses in programming were being written and tested, it became clear that additional areas of the curriculum could be integrated into these courses and the concept of the computer as an independent curriculum area solidified (Joiner, Miller, Silverstein, 1980). Under this new umbrella, courses in various programming languages developed; vocational computer education courses were implemented to teach students the skills necessary for computer related jobs; business courses were redesigned to give students experience in word-processing, data-base management, and automated accounting (Bork, 1978-79); computer science

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emphases also developed, covering such issues as computer theory, design and analysis.

Out of all this, sprang the new "buzz-term" for the 80s—"Computer Literacy." As the number of computer applications in society grows and as more and more microcomputers are available to all students, the need for a well-informed, well-trained, computer oriented population increases (Molnar, 1978-79; Poole, 1982). This very day, symposiums, lectures, presentations and courses are being developed around this single issue of "computer literacy." These rapid advances created serious problems for the professional educator who received little, if any, training in these areas.

The appropriate application of microcomputer technology to instruction implies changes in American teacher education. Both "computer literacy" and uses of microcomputers as teaching tools must be integrated in meaningful ways into pre-service teacher education. Educational technologists who understand the wide impact of technology on education should provide leadership for this instruction. It is unlikely that appropriate microcomputer competencies can be developed in existing methodology courses. Courses or other major learning segments in educational technology taught by technology specialists are necessary to the development of the in-depth knowledge and competence required.

Likewise, in-service courses for teachers are mandatory if schools are to implement microcomputer technology. One-shot courses, conferences and workshops can generate interest and develop awareness; however, they must be followed with extensive coordination, consultation and guidance if microcomputers are to be integrated appropriately into classroom practice.

Educational technologists who have extensive competencies in microcomputers are required if meaningful leadership and direction are to be given to this revolution in American education. These technologists must know more than just microcomputers; they must be based broadly in educational technology. They must know how humans learn and how instruction should be developed to facilitate learning best. Unfortunately, few such technologists are being prepared today in our colleges and universities, and few school districts have such personnel in the numbers necessary to facilitate appropriate integration of microcomputer technology into instruction.

While educators were still trying to "spread the computers around" so that more students could gain "hands-on" experience, while they were still trying to find or develop appropriate software, while they were still engaged in curriculum design and implementation, and while they were still searching for qualified professionals to teach and manage the microcomputers, the revolution assaulted yet another flank. Advanced applications of the type previously limited to large mainframe computers were being adapted to the microcomputer. Tremendous strides were taken in the micros word-processing capabilities. "Mini-Authoring" programs were developed; educators with little or no experience could use "skeleton" programs to provide computer structure for their course content. Teacher designed and produced CAI programs, quizzes, worksheets, and a host of other paperwork-type tasks could now be relegated to the school microcomputer.

Electronic worksheets (Visicalc-Commodore), which automatically calculate and recalculate rows and columns of figures, presented immediate administrative applications. As the number of microcomputers in the school increased, the ability to "network" (use one unit as the central memory for several other terminals) developed. This allowed the teacher to monitor several students at separate terminals, working on different programs, at a single central unit. And the combination of computer technology and video technology has created "interactive video," which presents even greater demands on the instructor than the original "drill and practice" programs that baffled many (Bork, 1978-79).

Educational leaders must take a comprehensive approach also to the use of the various newer electronic technologies available today. Microcomputers cannot contribute maximally to instruction in isolation from other technologies. Cable television systems, satellite communications, digital telephone networks for linkages between computers, low-powered localized broadcast systems and especially videodisc technology must be integrated into functional instructional communications systems capable of implementing the complicated processes which comprise human learning. Thus, it is unlikely that dropping microcomputers into technologically barren classrooms will result in significant change and improvement. A unified, holistic approach must be taken to the technological upgrading of American education.

The revolution is not complete, but in less than a decade, the microcomputer has infiltrated the breadth and depth of the educational system. The Congressional Office of Technology Assessment in its 1982 publication, *Information Technology and Its Impact on American Education,* stressed that "a broad approach, which takes into account the changing needs for education and training, considerations of equity and changing institutional roles will be required." Microcomputers have arrived in force in American schools. With them have come both a host of opportunities for improvement and challenges for change.

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