Computer Literacy: The What, Why, and How

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It is getting to be impossible to pick up a newspaper or a magazine without seeing articles, news items, and ads about computers. These little machines, which get smaller, better, and cheaper every month, are appearing in the office, on the production line, in the school, and in the home. Their innards are inside cars, TV sets, microwave ovens, thermostats, typewriters, and telephones. It is becoming clear to all that this new technology is going to affect the way we work, play, live, possibly even the way we think.

In some ways, what is going on is like the electrification of America, which began a century ago and had enormous effects on our lives. The light bulb turned night into day and, among other things, made the three-shift workday possible, which in turn made it economical for factories to own and use costly heavy machinery. Huge electrical power plants were built, and the nation was blanketed with a woven network of power lines, carrying energy to electric motors far from the power plants. The motors became smaller and smaller and took over one manual task after another, at work and at home.

Yet the coming of electricity and the coming of computers are profoundly different from one another. No one in the last hundred years has ever claimed a crying national need for electrical literacy. Twelve-year-olds aren't learning much about electricity in school. In fact, though each of us uses the benefits of electrification many times each day, few know how electricity works or even how to make simple repairs to an electrical circuit. "How many suburbanites," the joke goes, "does it take to screw in a light bulb? Answer: Two. One to call the electrician and one to fix the martinis."

Computers are different. There is a general perception that to make effective use of them we are going to have to know a lot more about them than we need to know about electricity. A motor runs, after all, whether or not we understand why. But a computer does nothing unless someone tells it what to do. There is a growing feeling among people that if we are to get the most out of the computer revolution, we will have to learn how to tell computers to do things. In short, we must become computer literate. The task is not difficult: witness the fact that tens of thousands of children today are learning to use the computer in school.

What?

A few years ago there was a lot of confusion about what computer literacy meant. Some people were arguing that a person could become computer literate merely by reading books or watching movies or hearing lectures about computers. That viewpoint probably came out of a time when computer equipment was expensive and, therefore, not often found in classrooms. Teachers had to teach something, so they taught "facts" about computers: their history, social impact, effect on jobs, and so forth. But such topics are more properly called "computer awareness," I believe.

Even the fact that a school or district possesses one or more computers must not be taken as evidence that education in computer literacy is taking place. Many schools use computers for attendance and grade reporting, for example. These administrative uses may improve the cost-effectiveness of school operations, but they teach children nothing at all about computers.

Other schools may be using computers solely to run programs that drill their students on math facts, spelling, or grammar. In this kind of use, often called Computer-Assisted Instruction, or CAI, the computer prints questions on the display screen, and the student responds by typing answers on the keyboard. Except for rudimentary typing skills and when to press the RETURN key, the student doesn't learn how to do anything with the computer, though. Here again, a mere count of computers doesn't tell anything about what students may be learning.

A third kind of use comes closer to providing computer literacy, but it too falls short. In this mode, the computer, together with one or more programs, is used to provide some kind of illumination of material in a regular, noncomputer course. A social studies teacher, for example, might use *The Oregon Trail* simulation program to illustrate the difficulties pioneers encountered in trekking across the American West. Such an application not only teaches American history, it also shows students that computers can be made to simulate things and events—a powerful notion. Yet neither in this, nor in any of the other educational uses of the computer I have mentioned so far, does a student actually learn to take control of the computer.

Literacy in English or any language means the ability to read and write: that is, to *do* something with the language. It is not enough to know that any language is composed of words, or to know about the pervasive role of language in society. Language awareness is not enough. Similarly, "literacy" in mathematics suggests the ability to add numbers, to solve equations, and so on: that is, to *do* something with mathematics. It is not enough to know that numbers are written as sets of digits, or to know that there are vocational and career advantages for people who can do things with mathematics.

Computer literacy must mean the ability to do something constructive with a computer, and not merely a general awareness of facts one is told about computers. A computer literate person can read and write a computer program, can select and operate software written by others, and knows from personal experience the possibilities and limitations of the computer.

Why?

Parents increasingly perceive that computer literacy for their children may make the difference between a job and no job, between an open-ended career and a dead-end career. Reading, writing, and arithmetic are no longer enough.

This public perception is absolutely correct. Consider how many jobs today require working directly—not with farm animals, or machine tools—but with information. At present more than 50 percent of the work force deals mainly with information, up from 25 percent at the time of World War II, and 10 percent at the turn of the century. During this century, agricultural jobs have all but disappeared. Manufacturing jobs replaced agriculture at first, but for the past fifteen years they too have been on the decline. Some future-gazers predict that by the year 2,000, when today's eighth grader will be in his or her early thirties, 80 percent or more of all jobs will primarily involve handling and using information. A computer, let us not forget, is first and foremost an information machine. As the steam engine amplified our ability to do manual work, so the computer amplifies our ability to work with information. Those who know how to use information machines creatively and productively will best qualify for the careers of the next half century. Those who do not may be left behind.

There is more to computers than jobs, however. If that were not the case, I would question whether computer literacy should be an important goal in the education of fairly young children. There is general agreement that the main purpose of the first eight to ten years of school is to give students some very basic intellectual tools for thinking, writing, and expressing ideas and feelings. The seventh grade curriculum shouldn't be determined entirely by the job market, most would agree.

Should the schools treat computing as a vocational subject and put it in the high school business department, mainly for non-college-bound students? A few people have said that, but they have missed a very important point. When students are doing computing, they are mastering a new intellectual tool. When they write computer programs, they are expressing ideas. When they read programs, they are looking for meaning. When "debugging" programs and trying to get them to run correctly, students are exercising problem-solving skills of a high order.

Computing belongs as a regular school subject for the same reason that reading, writing, and mathematics are there. Each gives the student a basic intellectual tool with wide areas of application. Each gives the student a distinctive means of thinking about and representing a problem, of writing his or her thoughts down, of studying and criticizing the thoughts of others, and of rethinking and revising ideas . . . whether embodied in a paragraph of English, a set of mathematical equations, or a computer program.

There is a third reason why computer literacy should be a standard goal of education. Anyone who has worked with people who are learning to use computers has seen the personal satisfaction that accompanies an increasing mastery of these new skills. Quite young children will work intensely on a programming problem for many minutes at a time, breaking out in enormous grins when the computer finally does what they wanted it to. Adults try to be more secretive about their own satisfaction, but it often likewise slips into view.

In this sense, work on the computer seems to be more like developing a physical skill, such as learning to ride a bicycle or learning to ski. Hours of time, many scraped knees, or much snow in the mouth are accepted rather easily in return for the satisfaction of finally gaining control of the activity. A small number of students, perhaps 5 percent, approach intellectual tasks with the same persistence. For others, gaining control over mathematics or writing appears to be so distant a prospect that they experience only the scrapes and bruises, with rarely the satisfaction of accomplishment. Yet all students seem to be able to achieve a satisfying mastery of the intellectual skills needed to program the computer. This is a remarkable phenomenon by itself. But there is growing evidence that for many students the success of learning to use the computer is the beginning of a productive approach to learning in general.

How?

Few schools are fortunate enough to start their computer course with a full complement of equipment. Most begin with a single computer and work up quickly to a stable plateau of five to eight machines. This allows two or three students at a time to share the computer. The situation is not ideal, but it seems to work acceptably for a few years. However, a student's hands-on computer activities are most effective in a one-on-one situation. Does that mean that a class of thirty students ideally ought to have thirty computers.?

Fortunately not. For while the hands-on component of a computer literacy course is crucial to its success, not every class period should be spent in the computer lab. At least as much time needs to be spent in the classroom with the teacher, developing general ideas about the way a computer works, learning how to write for the computer, learning to read programs, and so on. So the computers would often remain unused if all thirty students were in the classroom at the same time.

A simple scheduling strategy cuts in half the need for equipment. Imagine that it is Monday, and you are teaching a computer class in the third period. You send half your class to the computers, and keep the other half with you in the classroom. The computers may be in a partitioned portion of your room, or in the room next door, or even in another building. It doesn't matter, because the students have a manual that carefully directs their activities at the computer. They don't need your guidance there, though a student or adult aide can be of help. Back in the classroom, you conduct a regular class with the fifteen or so students who remain. You review the students' previous hands-on session. You introduce vocabulary and concepts. You lead them through close analysis of programs. You give them paper-and-pencil problems in programming. You give quizzes. Of course, with such a small group, there is more opportunity for discussion and individual attention.

Now it is Tuesday. The students who were in the classroom on Monday go to the computers today, and the others come to class. You repeat your Monday lesson plan with these students. Wednesday is like Monday, and Thursday is like Tuesday. Friday is an ad lib day, available for lab makeup, exams, general group discussions, or whatever the teacher finds appropriate.

The result of this alternating schedule is that the school needs only half as many computers for the same number of students, and the computers are fully employed. A single set of about fifteen computers can give optimum programming experience to a class of thirty students. If the same course is repeated over five class periods during the day, the computer laboratory provides intensive, hands-on experience to about one hundred fifty students a semester. Thus three hundred students a year—fifteen hundred over five years—could take a single-semester introductory course in computer literacy. The computer lab for such a course, containing from eight to sixteen computers, should cost between $10,000 and $20,000 (including maintenance) every five years. Equipment cost per student enrolled in the course, therefore, comes to between $6 and $13. These costs are within the means of nearly all schools, and for most schools an investment of this size pays enormous dividends to individual students and to the community.

The vocational, intellectual, and personal payoffs of computer literacy are very handsome. So handsome, indeed, that many school systems are besieged by voices crying out for computer literacy for all students. The clamor could not have arrived at a worse time. Student populations are declining, along with community support for schools. Capable teachers are leaving the system. Operating budgets are shrinking. Costs are rising steeply. How will a school find money to equip a computer lab? Who will teach the course? What about teacher training? What about curricular materials? What course will give way to make room for the computer course?

These are not easy questions, and at present, many of the attempts to answer them are far from perfect. As might be expected, the children of affluent parents—parents who are themselves information workers—have four or five times as great an opportunity to learn to use computers as do children whose parents are manual workers. This inequality of education can only lead to an even greater inequality of opportunity in the coming decades. The surprising fact, however, is that so many schools are actively taking steps to bring computer courses into the curriculum. At the beginning of 1982, there were about 100,000 computers in the U.S. schools, a number that is growing at a rate of 50 percent or more per year. This growth has occurred virtually without any assistnce from federal or state agencies. More often than not, it is the Parent-Teacher Association (PTA), an individual parent or teacher, or a single administrator who sparks this explosive growth. Until recently, teachers have had to create most of the instructional material, and they have had to train themselves. But our work and that of others are beginning to provide practical classroom-tested textbooks and lab manuals for these courses. Teacher training in this area is still uncommon, but by 1982 some schools of education had already taken up the challenge.

What will happen in the next few years, when literally millions of students arrive in high school each year with a semester or two of computer literacy already behind them? Experience suggests that a little computing is like a single peanut: you want more. High schools will be pressed to offer computer application courses in business and other departments, as well as new computer science courses. Colleges will be relieved of the need to offer most of their present introductory computer courses, and most will be pressed to provide more advanced courses.

And what of the adults who have missed out on computer education at school? Some will learn along with their children. Some will go out, buy a computer and a few books, and teach themselves. And some will get along without ever learning about computers. After all, not every adult learned to read and write back in the middle of the nineteenth century, when schools decided that every child should become language literate.