FIVE MODELS FOR USING COMPUTERS IN SCHOOLS:
PERPECTIVES FROM THE UNITED STATES OF AMERICA

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Many of us who have served as teachers/consultants/advocates for
introducing computers into schools are saddened and frustrated
by what appears to be a tremendous confusion, even conflict,
surrounding this process. This is due partly to the fact that
computers represent change and change is always difficult.
However, we began to see another and equally fundamental
problem which is accompanying the computer revolution. This
problem has three critical factors. First, people subscribe to
strikingly different models for utilising computers in schools (2).
Second, this is often true even for collections of individuals
working in or for the same institution: e.g. teachers, principals,
parents, students, school board members, etc. Third, these models
are largely implicit; that is, people are unaware of the major
assumptions which they hold about how to use computers in
schools (3). As a result of these factors, protagonists argue
themselves blue in the face about what's the best computer to
buy, for example, when what they should be arguing about (or:
better, discussing) is which model of computer use is appropriate
for a given educational setting. Once agreement has been reached
on the model which deserves implementation, issues relating to the
nature of hardware; software; in-service training; client
population; and so on are mostly self-evident, i.e. no more
arguments!

In our analysis we have identified five models which have been
espoused by some segment of the population of "experts". The
most exciting model is the computer as intelligent tutor, an idea
espoused by Patrick Suppes, among others (4). Unfortunately,
this model is a long way from practical realization (5), or as
Michael Crichton so aptly expressed it in Electronic Life, rather
than looking to artificial intelligence to solve educational
problems, "You'd be better off whispering sweet nothings into the
tailpipe of a Chevrolet." (6). In more prosaic terms, it will be
several years before really intelligent computers are cheap enough
to be used to teach all students the Pythagorean theorem, or the
decision of a Latin noun, or even how to tell time.
Unfortunately, many educators got sold on the tutor model at some point and these are the people who continually gripe about the dearth of good educational (read "tutorial") software.

The vocational model currently dominates public school computer classrooms (7). There are several reasons for this, not the least of which is that school purse-strings are held by school-board members and PTA presidents, who, more often than not, are business people. The design of a vocational program is relatively straight-forward because schools need only get in line and stay in step with the business community; as new vocational applications are developed and applied, they can be transferred directly to the computer classroom. There is widespread public and political support for the vocational model as reflected, for example, in the rush to develop mandatory curricula in computer literacy (8).

Some of the more typical elements in a vocational model include (9): minicomputers; dedicated word processors; Apple and IBM personal and micro-computers; and this equipment is used for: word-processing; typing; drafting; programming; and computing. The vocational model is most often utilised in a labsetting by a special teacher. While there have been some very positive additions to the curriculum as the result of the push to implement the vocational model, we believe it has been vastly oversold and is responsible for the increasingly evident backlash against computers in education (10). Learning a programming language and/or learning computerese (the typical content of computer literacy classes) are not necessary prerequisites to learning to use computers (11). To succeed in the computer age people need, above all else, to "make friends with the machine" (12) and the typical computer literacy course is far more likely to lead students to "make enemies with the machine". Implementing the vocational model can be very expensive (13). Business demands the latest, most powerful, and versatile hardware and software available which inevitably translates into "most expensive". For schools this means that they will be able to install at least five computers for every one "electronic workstation". In addition to the very high hardware and software costs, the vocational model typically requires a "dedicated" room and instructor, as we have seen. Thus, schools which wholeheartedly embrace the vocational model are often faced with three unattractive choices: to rob other areas of the curriculum materials and/or capital budget to pay for the computer program; to run an "affordable" program in which the equipment and materials are obsolete or otherwise unlike that found in the work place or; offer a high quality program to a very select group of students. The resolution of this dilemma lies in implementing the vocational model only where it will do the greatest good.
It makes sense, for example, to teach keyboarding, word-processing, and spreadsheet in conjunction with an 11th-12th grade business/secretarial track, as all of the corollary skills can be integrated at this time and the newly acquired computer literacy can be applied directly on the job following graduation. It makes sense to teach programming as part of an advanced placement 12th grade math/science track. The programming skills will directly benefit the students in their science and math classes and will aid them in their college classes in these subjects as well as in engineering. Contrariwise, it does not make much sense to try and implement the vocational model in the second grade.

The most venerable of the five models is the computer as instructional medium better known as computer-assisted-instruction (CAI). As long ago as 1972 (dark ages in computer history) fully-fledged curricula in spelling, grammar, math, geography and so on were available on such main-frame based packages as PLATO, for example (14). The cost of implementation was, of course, prohibitive, but, over the years, CAI has become cheaper and better. Caveat emptor: the A in CAI still stands for "assisted", don't expect computers to teach a child anything much or even remediate (in the sense of diagnosis/remediation). However, if you are concerned about getting children to practice skills or rehearse facts often enough to achieve real mastery, CAI is for you (15). Inexpensive CAI comes along just in time to save students and teachers from being overwhelmed by the latest wave of "back to basics" hysteria. Students and teachers avoid drill and practice exercises not because they'd rather be clarifying their values but because D&P worksheets are boring to do and even more boring to grade. D&P computer games, on the other hand, are less boring (in fact, they are most appealing to the kids who need the most practice) and the program corrects the students' answers (16).

Enhanced student motivation and reduced busy work for teachers are the two principal benefits available with the best instructional software (and make no mistake, there is a lot of excellent software available for this purpose). In other respects, those who advocate and use the "instructional medium" model have not ventured far from the content and methods found in other, more traditional, instructional media.

Once a decision has been made to implement the CAI model, one's choices are quite varied. We would recommend either Commodore 64 or Apple II systems, the latter has somewhat more CAI software available, but the hardware costs at least twice as much per station. Each system must include a CPU, disk drive, color
monitor, and a pair of joy sticks. With respect to software, one can either purchase a package deal from such companies as DLM, Milliken, MECC (this is not an endorsement) whereby all of the fundamental skills associated with the elementary grades have been included and are carefully sequenced and "levelled" or, one can, with careful and painful evaluation, create a D+P library from among 100's of programs available through dozens of publishers. Most programs do not require teachers be particularly "computer literate" so this model can be implemented easily in individual classrooms. It can also be implemented in a dedicated computer classroom with equally good results. At present the principal use of CAI in the middle and high school would be for the review of skills taught in K-6, however, good CAI programs in typing, algebra, and anatomy are available and programs in physics, chemistry and geometry will soon be available.

Note that the CAI model implies a commitment to curricula which were present in the classroom before the computer arrived (17). However, our last two models offer interesting possibilities that have only rarely been explored in the schools.

The fourth model is hard to describe but it is one which we think may be very appealing to some teachers. This is the computer as mental gymnasium. Exponents of this model include such people as Seymour Papert and Herbert Kohl. The LOGO programming language, for example, was developed to enable children to interact with the computer and, thereby, acquire the mental discipline of a programmer (18). Patricia Greenfield in her recent book Mind and Media ascribes somewhat similar qualities to wordprocessing (19). By extension we might expect electronic music, art and design to stimulate the development of thinking, planning, communicating, imaging and other "high-order" skills. Furthermore, one can argue very convincingly that these skills will be heavily utilized by individuals who will lead the high-tech revolution.

The major difficulty with implementing the mental gym model is that it really does require a leader/organizer who knows what he/she is doing (20) - this is the model which can't be copied out of a manual, or copied from business or picked up in a university course, it must be built from the ground up. One has a wide array of choices again, but it is important to point out that one can put together (e.g. find software to support) a fine mental gym based on the cheapest "real" computer on the market, the Atari 800 XL; also, a full array of well-designed and inexpensive peripherals are available for this machine.
A second difficulty with the "mental gym" model stems from the undeclared goals of mental gymnastics. Many schools have allowed LOGO, for example, to be wholly incorporated into their vocational model. Thus students are given "exercises" to carry out in order to "master" the "subject". This, of course, totally defeats the intentions of the people who developed these child-sized programs. Instead of the computer becoming the object and the child the programmer, the child is the object and the teacher is the programmer -- in other words, business as usual. On the other hand, most children do not do well in a purposeless environment. Students engaged in programming, word-processing, graphic design etc. without having to fulfill an "assignment" often flounder around rather aimlessly (the exception: academically-gifted children, and they may be the best clients for the mental gym model) (21). Thus we would recommend that educators who are interested in implementing the mental gym look carefully at various "construction" programs. These require the mental skills associated with mastering the computer environment, but they come with built-in, kid-oriented goals (22). Outstanding examples of the genre include: "The Pinball Construction Set", "Robot Odyssey"; "Bank Street Storybook"; "Adventure Master" and "Ranch". A final word of caution concerning the "mental gym" - a ten minute a day "workout" does very little good. To get full benefit from their work-out, children need to spend at least a half hour and preferably an hour at a time on the computer and, once they get started on a project, they should be able to work on it every day or else they will lose interest.

Our final model, the computer as activity corner, is rarely seen in schools although it is our personal favorite. It is far and away the easiest and cheapest to implement. Two concepts link this model to the activity corner (23). First, if you have a decent software collection, there are all sorts of things you can do with a computer. Second, learning to do these things occurs largely without instruction or other intervention on the part of the teacher. Thus a teacher can: get his students fully involved with computers; acquire a superb reward for good behavior and good work; provide outstanding enrichment opportunities and so on, without knowing anything about computers, computer-based-education; programming or what have you (24). Atari 800XL or Commodore 64 machines are appropriate. There are more programs on the market for the latter, but a station costs at least one third more and disk programs are not self-booting. The disadvantage of disks which have to be booted is that kids don't read the documentation or it's been lost so they come to the teacher for help. However, both the Atari and Commodore machines have ROM cartridge ports and cartridges do self-boot so we
recommend that pre-school – first grade activity corners only use programs that are stored on cartridges.

Of the three major markets for commercial software: business/industry; home; and school, this last is by far the least lucrative. Hence, educational software as a category is relatively uninspiring (25). The activity corner concept encourages a teacher to look at the "home" category where the pickings are much richer. There are many, many games and other "fun" programs that offer valuable opportunities for both intellectual and social growth. Among the leading publishers of software which meet these criteria are: CBS; Spinnaker (including their various subsidiaries like Fisher-Price); Sierra (especially the Disney line); Electronic Arts; The Learning Company; Mindscape; Sunburst; Broderbund and Xerox. The best source of ideas and, indeed, for the loan of programs, are the kids themselves, particularly those who have access to a computer at home. Just as there are children who live and breathe baseball or rock star trivia, there will always be a few around whose knowledge of computer software is near encyclopedic. Computer activity corners can also be valuable additions to the middle and high school classroom. Here we would emphasise the various simulation and adventure games (25).

We intend in the future to expand this paper and draw on the accumulating research literature to articulate these models in greater detail. However, we would like to end with a word of advice. That is, that educational personnel need to spend a great deal of time discussing the merits/demerits of particular models for computer use in schools. They need to be clear which models are relevant and what the components of those models are. Then they need to decide which model(s) to implement where and in what order. What we keep seeing are good models in bad places (e.g., vocational model in the second grade) or mixed-up models (CAI/Mental Gym) that don't do anything very well. Next comes a careful look at the budget. Only when these issues get resolved can the discussion turn to the actual purchasing decisions. However, if a lack of consensus or lack of money at the district level has kept computers out of your school, go for the activity corner model – the PTA will love it.

Notes

1. Our work has been consistently supported by the Edith Bowen Laboratory School, as well as by: Atari, Commodore,
Sunburst, Spinnaker, Electronic Arts, Microlearn, Sierra, Disney, Xerox and many other companies too numerous to mention.


5. The most advanced prototypes are the BUGGY and DEBUGGY programs to diagnose a child’s "buggy" algorithms for solving arithmetic problems, J.S. Brown and R.R. Burton, Diagnostic models for Procedural Bugs in Basic Mathematical Skills; Cognitive, Science, 1978, 2, 71-109.


9. Computers have an obvious role to play in improving school and classroom management, however, this article will be limited to discussing the instructional uses of computing. See W.J. Bramble and E.J. Mason, Computers in Schools, NY: McGraw Hill, 1985 for a discussion of this distinction.


Recent forecasting studies indicate that very few workers in future will need to know how to program. Most new jobs in the computer field will eliminate and/or simplify tasks.


Tom West, a noted computer engineer, illustrates this phenomenon in a comment about the introduction of bar-code readers at the check-out stand: "one of the problems with machines like that (is) you end up making people so dumb they can't figure out how many six-packs are in a case of beer."


M. Crichton, op.cit. p.77.

Paradoxically, if the only feature of the vocational model that schools want to implement is programming, this can be done very cheaply using computers like the Timex 1000; the TI 99/4A, the Commodore PET and the BASIC programming language. However, Alfred Bork, for one, has argued that students should not be taught BASIC because they will develop bad programming habits and will be handicapped in learning modern, structured programming languages like LISP and PASCAL.


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without being justified. Apparent free-learning and social in-
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of no more than a large well-padded rug where two or more
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