Computer Center

Computers and Education

Thomas C. O'Brien
Guest Editor

What's the future of computers in American education? A boom or a bust or somewhere in the middle? Let's look at the issue in context.

The present goals of American education at all levels are largely concerned with static knowledge. That is, they are concerned with the reception and storage of information and associations. In general, learners are viewed as receptors.

Therefore, transmission, repetition, and reward are the principal means of education. The student is a passive entity, and knowledge is seen as "stuff" to be stored and brought up at test time. Teachers focus on more efficient ways to transmit associations and school administrators focus on numerical data purporting to measure students' retrieval of associations, facts and conventions.

The problem is that it works! Organisms—we are all organisms—adapt. Students learn the game and we are all the poorer. It is the rare teacher above fourth grade who reports that children are eager, inquisitive, and willing to tackle new problems. Kids are b-o-r-e-d and are labeled lazy. From fourth grade through graduate school, students often won't tackle an original problem. A physics professor from a prestigious university tells me, "My students won't work on a problem unless they can slip a ready-made formula out of their hip pocket."

How did such a situation come about? Much of the thinking about goals and means of American education comes directly from the assembly lines of 1910 when American school administrators embraced the Ford Motor Company as a model for education, adopting factory-oriented thinking with three themes: (1) mass production policies and practices; (2) cost-effectiveness; and (3) time/motion "efficiency" research. Read Raymond L. Callahan's classic *Education and the Cult of Efficiency* and weep.

Psychological research is a second influence on education. Many studies involve brute memory with meaning deliberately banished in order to ensure "scientific" cleanliness. Much of the research is not only concerned with performance under various external conditions of reward and punishment, but it involves animals rather than children.

A third prop to American education is perhaps the weakest and most disturbing. American education has seen a parade of fads and bandwagons. Remember the Initial Teaching Alphabet? Programmed instruction? Modern math? Behavioral objectives? Performance-based contracting? The open classroom? The talking typewriter? Each of these innovations was proclaimed the be-all and end-all of educational solutions and the fact that none of them lasted attests to educators' short attention span, to their unwillingness to look at underlying issues, and to the resiliency of the factory/stimulus-response model of education. Are computers in education another bandwagon?

There is, in fact, a body of research on education quite different from the brute memory/nonsense syllable/external reward tradition. Sixty years' research by Jean Piaget and collaborators throughout the world show knowledge to be an active construction, a growing fabric of ideas and relationships rather than an inert collection of facts and associations.

In this view, one's fabric of knowledge constantly interacts with the outside world, and the outside world acts on the fabric modifying it to incorporate the new reality. The reality so organized by the mind tends toward coherence, stability, economy, and generalizability.

Two other aspects of this theory are worth noting. The fabrics of a six-year-old are smaller and less numerous than those of most adults, of course, but—more important—they are intrinsically different from ours. A child's cup of knowledge is not only less full than an adult's but it consists of different stuff.

Second, one's fabric of ideas doesn't only interact with reality but tends to develop and grow. If the conditions permitting and provoking extension and elaboration of the fabric are available, development takes place. If not, growth is stunted and the organism seeks fruitful interaction with other realities.

The key to learning according to this theory is dissonance, i.e. mismatch between where we are and where we want or need to be. The dissonance must involve a moderate mismatch with the fabric. If it's too small, boredom sets in. If the dissonance is too great, (differential equations for the average 12-year-old) there's more boredom and a move to arenas in which moderate mismatch obtains. But given moderate dissonance, we act as though pre-wired. Dissonance is irresistibly engaging.

There are many aspects of dissonance that lend themselves to educational situations. A major aspect of dissonance—widely employed in present schooling—is competition. But what about self-competition? Challenge? Surprise? Regularity and its absence? Novelty? Mystery? Uncertainty? Complexity? Ambiguity? Curiosity? Quest? Where in the educational literature, or in teachers' guides, has attention been given to these issues, except to warn against such stuff?

All of this sets the stage for several points about computers, interactivity and dissonance:

Computers in the classroom and the home can provide individual children and children in small groups with moderate dissonance at the child's level of choice, thus making learning an active construction rather than a passive warehousing. Contrast this situation with the traditional classroom where all children work the same textbook, often the same page!

Computers can transcend local space/budget constraints and reach

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out across the nation at a cost of pennies. Information services such as CompuServe and The Source help children search out the facts they need when they need them and Email systems and Bulletin Board can provide children and teachers with aid, information, and collaboration in their inquiry.

One of the major aspects of complex thinking is representation, a word derived from the Latin res praesentans, making a thing present. To make a past event present—and to make a new idea present—is at the heart of intellect.

Sad to say, representation gets short shrift in schools in favor of the transmission of facts and rules. Making things present is seen as trivial, something to do when the "basics" are done. The computer can bring graphic representation to the classroom through various graphics facilities and software such as Delta Drawing, LOGO, and Koala Pad, where children make things present in contexts of intellectual importance. With software such as Sound Chasers and hardware such as the Yamaha PC-100, children can engage an oral representation as composers of music. And speech synthesizers and software presently exist to turn print into voice for the visually impaired.

But perhaps the computer's greatest contribution to representation in school work is to facilitate written representation through word processing software such as The Bank Street Writer, Open Window, and the like. Here children can attend to ideas without the undue care generally given to neatness, spelling and the other cosmetic issues. Neatness takes care of itself, and the cosmetic repairs involve proofreading and a few keystrokes rather than hours spent rewriting passages.

One of the most obvious use of computers for dissonance and learning is through simulation. In these days of diminished equipment budgets, a vast body of computer software provides rich hands-on science experiences for students. For example, Artillery investigates the relationships between firing force, angle of firing, and the wind velocity in ballistics, and CatLab traces the effects of genes on animal characteristics through several generations.

But the richest source of dissonance for children is likely to be computer software in which problems are posed and children interact with the computer to construct, organize, refine, and extend their fabrics of thinking. Examples of such software—there are many—are Baffles, The Factory, Rocky's Boots, Taxman, and The King's Rule. Here four utterly essential aspects of the learning situation are apparent: (1) The player can choose the right amount of mismatch; (2) The player interacts with the situation—tries something and gains information to help refine or change or develop the try—and constructs a fabric (without any force-feeding of rules and recipes); (3) The issue goes somewhere of importance (in these cases, mathematical importance); and (4) There is no ceiling to the issue; one can generate offshoots and elaborations.

Fortunately, there is a growing number of computer programs, both commercially produced and in the public domain, which employ computers to get at the heart of learning without even a nod to the traditional means of education—transmission, repetition, and external reward. In these programs problems are posed and children interact with the computer to construct, organize and extend their fabrics of thinking without mindless drill and recall of useless atomistic knowledge.

Earlier I said that organisms adapt through interaction with the outside world, particularly in situations involving moderate mismatch with their present state. My final comment is brief, but it may say more than all the rest of the essay.

Up until now, computers in education have had two major instructional roles: (1) courses in programming, usually at the secondary level; and (2) rote drill and practice exercises; that is, the computer as "electronic blackboard." School computers are also widely used for such disparate purposes as class scheduling, classroom management, band-contest management, test-scoring, and emergency phone messages to parents.

The single most important impact of the microcomputer on education, I think, can be to revolutionize our approach to the central aspect of education, children's learning. Computers and good software can enable learning to be an interactive process rather than a storage of static knowledge copied from an inert page of print. That is to say, computers can legitimatize what we know about teaching and learning but—because of tradition, fear, ignorance, and passivity—we could attempt only rarely.

If American education can be regarded as an organism rather than as an assembly line (and good teachers treat it as such despite the factory system in which they toil), perhaps the availability of sound education through computers and computer software will provide enough dissonance so that we in American education can construct a fabric based on what we know about children and their learning rather than on what we know about Ford motor cars, rat memory, and nonsense syllables.

Additional Papers on Instructional Computing

Thomas C. O'Brien, "Software Encounters of the Second-and-a-Half Kind," *Classroom Computer Learning*, September 1983.

Thomas C. O'Brien, "Five Essays on Computers in Education," *Phi Delta Kappan*, October 1983.

Thomas C. O'Brien, "Wasting New Technology on the Same Old Curriculum," *Classroom Computer Learning*, November 1983.

Computer Workshops
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