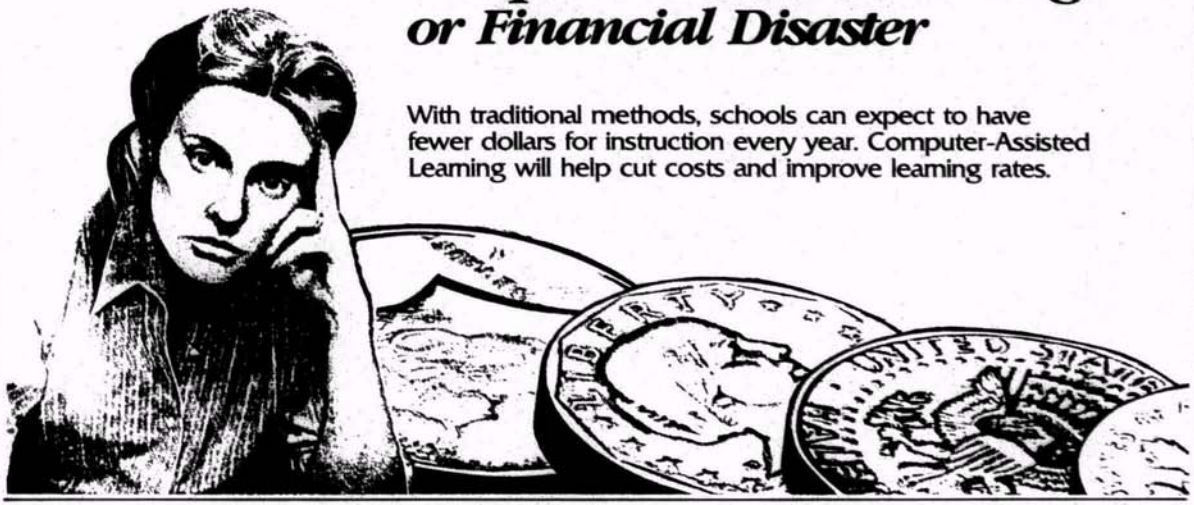
Computer-Assisted Learning—or Financial Disaster

With traditional methods, schools can expect to have fewer dollars for instruction every year. Computer-Assisted Learning will help cut costs and improve learning rates.



JOHN W. DAMMEYER

In early spring of 1976, a colleague and I projected public school funding needs and funding availability through the end of the century.[1] We found that in the 1950s the country had spent 3 to 4 percent of the Gross National Product (GNP) on public education. By the late 60s the rate had increased to about 7 percent and had leveled off in the first half of the 70s at between 7 and 7.5 percent of the GNP.

Our projections then assumed the following:

1. The GNP would grow steadily at 3.5 percent per year (the then-current Department of Commerce projection).
2. Public education costs per pupil would grow steadily at 3.5 percent per year.
3. The general economy would inflate at 6 percent per year through the 70s and at 5 percent through the 80s and 90s (the then-current Department of Commerce projection).
4. The cost of public education per pupil would inflate at the same rate as the general economy.
5. The 1975 percentage of each public school dollar spent on instruction would stay the same through the end of the century.

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When we projected monies to be available for public education at both 7 and 7.5 percent of the projected GNP, we found that by 1999 there would be a shortage of as much as 200 billion dollars a year—between 20 and 25 percent of the need.

A Second Projection

Nearly five years later, in the fall of 1980, I reviewed that projection. The second half of the 70s showed us to have been very optimistic. Instead of growing each year at 3.5 percent, the GNP growth rate had dropped after 1975, and I saw few reasons to believe it would not continue to drop. Declines in U.S. industrial productivity and negative trade balances continued, strongly indicating that GNP growth would approach zero in the rest of this century—or even shrink. A lesser growth rate than 3.5 percent would make the shortage of funds for education projected in 1975 even greater because there would be substantially less total money available.

Nevertheless, I continued to be optimistic and assumed that we did average a growth of 3.5 percent in the GNP in the second half of the 70s, and that this growth rate would average 2.5 percent through the 80s and 2 percent through the 90s. This was significantly less than the 3.5 percent figure we used in 1976, but it would still reflect a brisk economy. I assumed, more realistically this time, that the annual rate of inflation would continue at 10 percent. Finally, I assumed that of the 1975 total funding for education 55 percent would go toward instruction costs and 45 percent toward non-instruction costs (including capital costs), and that instruction costs would increase at 6.7 percent per year and non-instruction costs would increase at 18 percent per year.[2] This new projection showed that with 7 percent of the GNP available for education, we'd run completely out of instruction funding by 1990; at 7.5 percent of the GNP, we'd run completely out of instruction funding by 1992.

Another possibility was that we would break out of the 7 to 7.5 percent of GNP range and require more and more of the GNP until we would need over 12 percent by 1999. But where would we get that additional 4.5 to 5 percent? What would we give up? Leisure activities? Travel? Shelter? Clothing? Food?

I then looked at the public data published by the state of Minnesota[3] showing average annual costs per pupil for the years 1972–1978 (Figure 1). Bear in mind that the categories of "fixed charges" and "debt service" are not included in current operating costs; therefore the percent of total operating costs used for instruction in 1977–78 should be even lower than shown—actually more like 58 percent. Bear in mind also that capital expenditures are not reflected in operating costs.

As shown in Figure 1, instruction costs averaged a 6.6 percent annual

Figure 1. Annual Operating Costs Per Pupil in Minnesota.

School Year	72–3	73–4	74–5	75–6	76–7	77–8	Average Annual Change
Instruction Cost	719	758	846	923	893	957	+.0662
Non-instruction Cost	304	335	389	443	522	577	+.1796
Total Operating Expenses	1023	1093	1235	1366	1415	1534	+.0999
Percent of Total Spent on Instruction	70	69	68	68	63	62	−.0225

increase; non-instruction costs averaged a hair under an 18 percent per year increase. Total operating costs per pupil increased at 10 percent per year. And the percent of total operating costs spent on instruction per pupil dropped 11 percent in five years.

To me, the trends captured in Figure 1 were more than alarming. In the 1976 study we had assumed that the percentage of total costs spent on instruction would remain constant. Now—with less and less instruction bought per dollar spent—the already inadequate available funds would be spent less and less efficiently. Therefore, from the standpoint of the reason *all* funds are expended—to provide instruction—there would be an *instruction funding shortage* within the *overall* availability shortage.

In the fall of 1980, I wrote:

> In the traditional system, school administrators have virtually no control over the major non-instruction costs involving fuel, transportation, equipment, and plant maintenance. We should, I think, assume that in the eight years since the 1973 oil scare, school people have tightened up as much as is reasonable to expect. It is difficult to see any change for a long, long time. We should expect the non-instruction cost behavior to continue indefinitely *unless there is a very major change in the traditional education system.*
>
> And what has been, is, and will continue happening to the nation's body of teachers? When everything in their immediate world is increasing in cost at nearly *three times* the rate of their spending power? The answer is clear. Many of the better teachers will leave the public schools (and the profession). Many of the better students won't go into teaching. The quality of the remaining teaching body will drop. The average teacher age will increase significantly; new infusions of knowledge and perspectives will trickle out and die. And average salaries, not lowered by the salaries of starting teachers, will rise, with the result that the already inadequate instruction funds will pay for fewer and fewer teachers. . . .
>
> Within the overall educational funding shortage, there will be a dramatic reduction of instruction provided per dollar, and within *that* reduction there will be a further reduction of teacher quality and quantity. A dramatic change is required to avoid total collapse of our public school system.[4]

A New Projection

In this third projection I'll assume from the outset that the American people have already begun taking corrective action—somehow—and I shall try to reflect positive effects, especially on non-instruction costs, on an otherwise straightforward extrapolation.

This time, my assumptions are as follows:

1. The GNP will very gradually recover from virtually zero growth in 1980 to an annual growth rate of 2 percent.
2. Inflation will be politically manipulated through the 80s; the current conservative federal administration will bring the annual inflation rate to below 9 percent but will be supplanted in November 1984 by a less conservative administration; inflation will again reach double digits, climbing to 11 percent by 1988; a new administration starting in 1989 will bring about change that will enable inflation gradually to drop to 6 percent by the middle to late 90s.
3. The annual increase in school non-instruction costs will be reduced very gradually from their 1980 level to 9 percent by the end of the century.
4. Revenues available for schools will remain at a fixed percentage of the GNP, and in light of the increasing problems of the aged, it will be fortunate if the school revenue percentage does not shrink.

When projected, these assumptions result in the curve in Figure 2, which represents the percentage of 1980 value dollars available for instruction costs for the rest of this century; the curve also represents gain, where 1980s gain equals 1.

If this projection were to become an actuality, we would need either to cut the already shrinking curricular offerings in half, or to find ways to double instructional efficiency by 1999 in order just to keep abreast of the 1980s' offerings.

Just holding our own, of course, is not enough. The barrage of public criticism of instructional effectiveness has reached crescendo proportions. Rather than settle for maintaining the 1980s' level of effectiveness, we should be increasing it—by perhaps 20 to 50 percent.

One Proposal for Solution

I believe the best way to increase effectiveness and simultaneously control runaway costs is to develop a comprehensive set of individualized courses to be delivered primarily by computers. I am not suggesting that machines can replace teachers entirely. In the foreseeable future, there will be no practical way for a computer to transmit to the lesson author the immediate psychological condition of each student; that happens hand-to-hand, eye-to-eye, heart-to-heart. This is why we will always need teachers. It is essential, though, that we enable teachers to maximize this irreplaceable contribution. To help solve our educational problem the computer-assisted learning (CAL) delivery system cannot be used only as a modest adjunct to today's classroom teacher; *this requirement is the single most important factor in using CAL to help prevent the impending tragedy.*

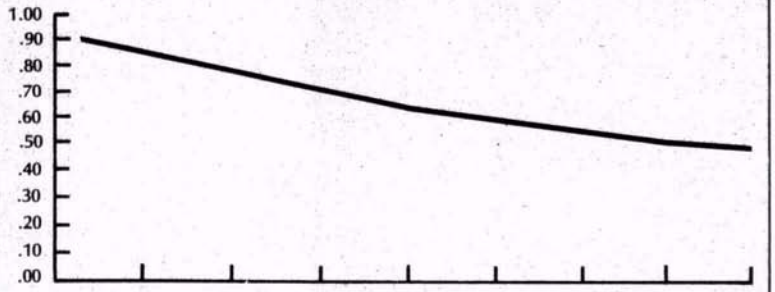
For instance, visualize a CAL system that keeps meticulous records of the hour-by-hour performance of each student and that can effectively present this information to the teacher at any time via the teacher's own CAL console. At home, the teacher spends two days per week—an average of one half hour per student—analyzing and evaluating each student's performance. In school, then, the teacher spends two days in individual conferences with each student—an average of a half hour per student—and one day in group work with the whole class.

This kind of individual attention will be possible, even though teacher-pupil ratios may be higher, because as schools gain experience using computers as the primary delivery system for instruction, the average learning rate will increase at about 20 percent per year until it becomes twice as fast as traditional delivery methods. Within ten years students will be learning more while spending fewer hours in school. We will need a third less teachers (the bottom third) and should be able to pay the remaining teachers a professional wage.

Problems Created

CAL offers a way to prevent curricular and financial catastrophe in our

Figure 2. Amounts Available for Instruction Funds in Terms of 1980 Instruction Funds.



schools. However, it creates other problems, some of which I do not have solutions for, such as the displacement of about one out of three traditional teachers.

Another problem has to do with the children and their parents. Working parents would lose 40 percent of the free babysitting services now performed by the schools at no *apparent* cost. Today, working parents with children *under* school age use daycare centers, and they view that cost as a personal expense that is part of the cost of working. This attitude would have to extend to elementary school age children as well. Certainly, secondary students could use some of the time that CAL would save to provide the additional services needed in daycare centers. In addition, towns would have to organize and administer athletic and recreational activities, as many of them do now.

To be sure, significant change will be required in any case. In a system dominated by CAL, the opportunity to learn will continue; in the case of a system dominated by traditional delivery methods, the opportunity to learn *will not* continue.

Unlimited Potential

Computer technology, the most widely applied technology spawned by science in the last 30 years, is not effectively used in education today. After nine years of research in all major aspects of computer-assisted learning, my major conclusions are that:

- The potential for effective use of computers in education is limited only by our attitudes and imaginations.
- The current trend is to adopt microcomputer toys that make tiny extensions of effectiveness to centuries-old educational traditions. *But, computers will not make appreciable improvements in education until we use them to deliver mainstream curriculum—for all students—in most subjects.*
- There is a serious danger that the opportunities for using CAL effectively will pass us by for another generation—maybe, from the standpoint of public education, forever.

It is an immediate and unavoidable challenge. If we are sufficiently open-minded and dedicated, however, we can lead the way to effectively using computers to improve education. This in turn will lead to improving the quality of life—maybe even at the greatly accelerated rate required to enable us to get back on top of our society's worsening problems before they, irreversibly, overwhelm us.□

[1]William B. Meher and J. W. Dammeyer, "The Coming Financial Crisis in Education" (Minneapolis: Control Data Corporation, 1976).

[2]According to data published in *Update* by the Minnesota Department of Education, this is the actual historical behavior during 1972–1978 for Minnesota, which I think is representative of the nation.

[3]*Update*, published by the Minnesota Department of Education, for school years 1972–73 through 1978–79.

[4]From John W. Dammeyer, *A Newschool* (Sedona, Arizona: Newschool, Inc., 1981). Reprinted by permission of the author and publisher.

[5]For more information, write EMCCO, Inc., 6050 Highway 179, Sedona, AZ 86336.

Wrong Reasoning, Right Solution: A Response to Dammeyer

CHRISTOPHER DEDE

Dammeyer's methodological approach and his assumptions about the future both are highly questionable. The concern he expresses about a potential fiscal collapse of the present mode of schooling is, however, well founded. The article thus identifies a real problem, but through faulty reasoning.

Dammeyer uses a forecasting strategy known as "naive extrapolation." A limited set of factors, selected from some brief historical period, is projected forward as if the world were forever condemned to mimic that behavior. This style of "surprise free" prediction was popular among prophets in the late 1950s, but rapidly fell into disfavor as it became apparent that the *most* surprising future of all is a straightforward extrapolation of the present over several decades.

In fact, history demonstrates that "wild cards" and other emerging trends invariably disrupt simple projections (witness the fate of Dammeyer's 1976 forecast!). Sophisticated extrapolators now generally use a combination of systems dynamics and cross-impact matrices to model the interaction of historical trends and unexpected events. Such an approach would be a better methodology for deriving a likely scenario for education's fiscal future.

The assumptions that Dammeyer makes in his 1983 prediction also are suspect. He assumes that annual growth in the U.S. GNP will be 2 percent or less for the rest of this century. In fact, a stable or declining GNP in the developed countries for the remainder of the century is likely to bring about a major global depression, with a whole set of challenges for U.S. education that go far beyond the scope of Dammeyer's discussion.

However, recent advances in the information and biological technologies seem capable of creating a "new industrial revolution" in America, with concomitant rising productivity, positive trade balances, and a return to at least moderate affluence. (The National Center for Research in Vocational Education has recently published a paper in which I discuss the likely path this reindustrialization may take and its implications for education). This is not to say that a successful economic transformation is guaranteed—given our present policies, it may be in jeopardy—but

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