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ABSTRACT

The media has criticized the American education system for being slow to implement technology in schools. To remedy that perception, the federal government and private corporations have planned additional funding for technology. This paper reflects on previous attempts to change, such as "New Math" or the "Follow Through" post-Head Start program, which fell short because of an absence of vision, inconsistency with school culture, lack or misdirection of resources, or lack of planning. Today's would-be innovators must guard against similar failures. (Contains 13 references.) (BEW)

Cautionary Verses: Prospects and Problems in Achieving the Aims of the Computer Revolution

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Abstract

Computer implementation in the USA is troubling commentators. To remedy perceived problems the federal government and private corporations have planned additional funding for technology--often as part of overall school reform efforts. Looking back at previous attempts at change we must be cautious about current plans for change. Earlier attempts failed or fell short of goals because an over-riding vision was missing. Innovations also failed because the plans ran counter to the culture of the schools or too few resources were directed where they would do the most good, or because schools did not know how to plan and work for change.

Key Words

Future Developments   Integration   Strategic Planning

Recently the news media have been offering "cautionary verses" about American schools' computer use. Here are a few of the verses:

Verse 1

Sadly, our overall record on computer implementation in schools is perhaps most appropriately compared to the mismanagement of savings and loan associations over the last decade. [1]

Verse 2

We have demonstrations of what's possible, but if you go on to a typical school, you will see that we're hardly using (computers) at all. We're good at innovation, but where we fall down is (implementation) because we are not a controlled educational system, like foreign educational systems. There is no similar use an implementation of technology here. [2]

INTRODUCTION

Teachers, government policy makers, and observers of the technology scene agree that America's use of computers in schools is in trouble. All agree that the dawning of the information age calls for students who can use computers for "higher order" skills such as comparing and contrasting data, making inferences from data, and looking for trends in data. Many visionaries see students using Internet and other services to access remote databases in order to collect and analyze data. All agree that many American students are not acquiring these skills—either on or off the computer—and that they are ill-equipped for the challenges presented by an increasingly technology-driven world.

American educators face five problems with technology use: (1) problems in creating a broad-based vision for technology use; (2) problems with using the technology once it has been installed in schools; (3) problems in achieving equity so that all students face the same types of computer-based experiences; (4) problems in documenting the impact of computers on students; and (5) problems in changing teachers' and administrators' attitudes about the place of technology and the use of technology in the teaching/learning process.

To move the schools forward and to coordinate government efforts to integrate computers into the curriculum, Senator Jeff Bingaman of New Mexico has proposed an office of technology within the Department of Education. Presumably, the office would coordinate various efforts—both in place and on the drawing board—to increase students' access to technology and their use of technology once computers have been acquired. Table 1, shown below, highlights several of those efforts and the funding associated with them.

Table 1
Funding Sources and Plans for Technology

Program	Funding	Sponsor	Goal
America 2000		Department of Education	Plan to reform education by the Year 2000
New American Schools	$200 million (private) $535 million requested from Congress	Department of Education	Proposal for $1 million each for 535 model schools—redesigned from top to bottom
USA On-Line	Information not available	Department of Education	Fiber-optic network to link homes and schools to educational sources
Smartline	$1 million from Congress	Department of Education	Network to connect schools and libraries with university and Department of Education databases on educational research
Office of Educational Research and Improvement	$250 million overall	Congress	Create an Office of Educational Technology to promote the use of technology in schools
Office of Educational Technology	$3 million	Congress	Support federal research in education with an emphasis on technology
Neighborhood Schools Improvement Act	$850 million	U. S. Senate	Provide funds to K-12 schools to help them achieve national educational goals; could include technology
High Performance Computing and Communications Program	$803 million	U. S. Senate	Plan to advance scientific achievement; call for a high-performance national network
K-12 Networking Project	private sources	Educom	National network to link K-12 teachers; long-term goal is to support curriculum

			reform
Chapter 1	$6.6 billion	Congress	Programs for disadvantaged students
Chapter 2	$475 million (estimated 30 percent for computers)	Congress	Educational block grant for state and local districts, some of which will support technology
Star Schools	$18.4 million	Senator Kennedy D-Mass.	Demo and magnet schools, telecommunications partnerships for instruction
Classrooms of the Future	$25 million	Senator Bingaman D-N.M.	Federal government would provide seed money for states and companies to develop software
Community Learning Network	private sources	Chamber of Commerce/ FCCSET/CPB	National fiber-optic network to connect schools

[3]

A lot of money! As the late Senator Everett Dirkson said, "A billion here, a billion there, and pretty soon you're talking real money." Real money for change and for progress can be a boon or a bust. It can help solve the five basic technology-related issues facing schools or it can complicate the problem by putting too much money chasing ill-defined solutions to poorly conceptualized attempts at addressing the five basic issues—if we in the USA even agree on those issues. Funding must be coupled with a real sense of what works—and it is not clear that we agree on what works or why it works.

To those who have observed the American educational scene for more than 25 years, there is a sense of deja vu about all of this. We have observed New Math, CSMP, SMSG, and other attempts to innovate mathematics teaching; BSCS, ESS, and other attempts to innovate science teaching; Man: A Course of Study, and other efforts to innovate social studies teaching; Head Start's and Follow Through's efforts to prepare disadvantaged students for the rigor of elementary school classroom; programmed instruction (both through print media and mainframe computer-delivered instruction), and Open Education. Now we're watching several states—California, Texas, Vermont, Florida, and New York, among others—as they seek to change their curricula. And we're keeping an eye on NCTM's curriculum reform movement, while we're watching the computer revolution. All this ferment for change impels us to hold up a mirror to the past to weigh the prospects for the future. For if we haven't done innovations well in the past, what guarantee do we have that we can manage the flow of dollars coming our way for technology?

THE PAST: ATTEMPTS AT EDUCATIONAL INNOVATION

The New Math. The New Math's history shows us that several factors play a role in an innovation's failure. The New Math ran counter to the beliefs-at-work of many teachers, parents, and administrators about what mathematics should be taught and how it should be taught. New Math was trying to teach sophisticated mathematics concepts while teachers and parents wanted the traditional "1 + 1 = 2 and 2 + 2 = 4" curriculum. In addition, the training demands of New

Math implementation were greater than the available resources of school systems. So teachers were handed textbooks and told, "Go to it, " without fully understanding what "it" was, how "it" should be taught, or why "it" should be taught at all. We can see the same problem today with computer-directed education.

Problems with evaluation also hindered efforts to gain acceptance for New Math: (1) large scale evaluation projects were relatively new and the wide range of evaluation techniques available today were not yet in place in the early 1960's; and (2) for the most part, standardized tests were used a outcome measures. Standardized tests were not sensitive enough to detect differences attributable to the New Math's instruction. Although New Math evaluators did devise their own tests based on New Math goals, those tests were not convincing to decision-makers (school district superintendents, school board members, parents, teachers, even students) skeptical about the New Math's value. Consequently, an oft-heard refrain "Will it get my child into Harvard?" was heard throughout the land. This skepticism about using non-traditional test data persists. However little of the New Math's reform efforts persists on a widespread, systematic basis, although the roots of NCTM's *Standards* can be seen in the New Math.

CSMP. Developers of the Comprehensive School Mathematics Project (CSMP) had the advantage of seeing the problems associated with the New Math. They attempted to build a program that would show the lessons learned from the New Math's problems. As careful as the model builders and evaluators were, they couldn't overcome a critical factor—individuals charged with carrying out the innovation on a day-to-day basis may not implement the project as planned. For example, in evaluating the impact of the Comprehensive School Mathematics Project (CSMP), Herbert [4] showed differences in the problem-solving performance of students—even though they had the same ability level.

Part of the difference in students' performance from one classroom to another was due to the differences in the way teachers implemented the program—some teachers jumped in and immersed themselves in the curriculum; others were hesitant about using it and taught a little bit, but not the complete curriculum as envisioned by the developers. As a result, some teachers championed problem solving, while others deformed the CSMP curriculum to an alternate way to do computation and only computation. In part, this explains differences in performance on problem-solving tests for students of the same ability level. This phenomenon of differential implementation is not unknown in American classrooms, especially in districts where a major criterion for acceptance of an innovation is the "It had better get my child into Harvard" syndrome. No innovations are adopted wholeheartedly in those districts unless school staffs believe using the innovation will not jeopardize students' standardized test performance. The irony is that, as we saw with CSMP, the "wholehearted adopters" usually found the project advanced students' performance beyond expectations.

CSMP remains in use in many school districts but has never gained the nationwide acceptance its developers in the mathematics community hoped for. Perhaps it was CSMP's one-belief system of how mathematics should be taught or the choice of non-traditional test to measure its effects, or the running against the grain of how mathematics classes are conducted that resulted in the limited adoption of CSMP nationwide. Perhaps teachers' fidelity to the program (or the lack of it) presented problems. Herbert, reviewing the data on observations of classroom practice at over 40 sites, said: "Teachers who had good generalized teaching skills, who were willing to prepare adequately in order to learn the content and lessons of the program, and who understood and agreed with the philosophy of the program were able to do an outstanding job ... . But this combination was hardly the norm; more commonly observed were lessons presented in a fairly competent way ... . For a significant minority of teachers, several pieces of the combination of factors ... were absent and the teaching of CSMP moved inexorably towards the more traditional approach." Sometimes the problems were based on the challenges of training teachers in the teaching methods required by CSMP with little time and not enough money; but sometimes the problems were based on teachers' active resistance to the philosophy-at-work of CSMP and its problem-solving orientation. Is this a precursor of the computer-using (or non-using) teacher?

Follow Through. Follow Through, a federally funded program designed to help post-Head Start students, recognized differences in teachers' philosophies-at-work and presented a choice of 7 models for adopting school districts. Each model was based on a different philosophy of education: two models were based on positive reinforcement (i.e., behaviorist principles), one model was based on the developmental model of Jean Piaget, one model was based on the English Infant School, and three were "drawn from Piaget, Dewey, and the English Infant School model."

Initial attempts to evaluate Follow Through were compromised by poor evaluation designs. Sites adopting different models were lumped together, even though the approaches to teaching and learning were fundamentally different and would be expected to produce different types of outcomes. As a result, skeptics said Follow Through did not deliver on its promises. Stallings and her colleagues [5] then designed an evaluation that took into account the planned variation in Follow Through and looked at several factors: the fidelity with which individual classrooms implemented the specific model chosen by their school district as well as the intellectual achievement of students. The evaluations included measures such as the Metropolitan Achievement Test, Raven's Coloured Progressive Matrices, an Intellectual Achievement Responsibility Scale, and ratings of "desired child behavior" that included measurement of independence, task persistence, and question asking—factors deemed important in one or another Follow Through model.

Whether the belief that young children deserve an edge, or the flexibility of the model choices or the weight of data were appealing factors, Follow Through persists, although Marshall [6] found, in a study of Follow Through classrooms in an urban school district several years after adoption, that over time the physical environment remained as envisioned by the model developers, but structure-of-the-program factors and teaching-strategies-to promote-learning activities deviated from the model. An analysis of achievement data, comparing Follow Through and non-Follow Through students also showed the Follow Through students were not consistently superior in performance to non-Follow Through students. So implementation and intended outcomes are difficult to maintain and the CSMP finding of moving toward "traditional" methods also occurred with Follow Through. It is interesting to note that within the last few months, members of the U.S. Congress have recommended a long look at Follow Through to remedy perceived problems with implementation—a concern generated by a series of on-going observations of Follow Through's implementation and impact. It seems it is difficult for teachers to maintain the developers' vision. In part lack of training is the problem; in part there is a clash with philosophies-at-work. Similar difficulties face teachers deciding on whether or not to join the computer revolution.

Title III-ESEA. Let's look at one more innovation attempt. Title III of the Elementary and Secondary Education Act (ESEA) was designed to support local school districts improve the quality of education by initiating a "bottom up" idea of change. The program helped school districts develop staff development programs, changes in school organization, or changes in the way subjects were taught.

In evaluating the projects funded by Title III, the Rand Corporation [7] studied ten sites attempting local variations on their current practices. Five case studies were conducted to assess how classroom organization changed as a result of the districts' decisions to change; five case studies were conducted to assess the impact of staff development programs initiated to support changes in instruction. According to the Rand researchers, "Our most arresting finding was how little change in teachers, social context, or student performance could be related to the project. There were changes, but they seemed more episodic, faint, and dispersed than expected." Do we hear echoes of problems identified in recent studies of technology use?

The Rand researchers characterized the changes in teacher attitudes and in instructional strategies:

> Only three projects changed teacher attitudes toward their work and place of work, but all projects could claim some changes in instructional techniques among some of their staff. Those changes were all in the direction of better, i.e., more behaviorally indicated, instruction . . . In successful projects, perhaps as many as a third of staff in as many as half of the project schools had changed as much as half of their instructional practice.

And, said Rand researchers, at another site, "the next most successful project," saw changes in only ten percent of the schools. At both sites, Rand researchers attributed successful change to the leadership skills of the project directors. With different leadership, the results at those two sites could have been different—i. e., if less dynamic leadership had been on site less change might have occurred. Remember that the Rand studies looked at non-technology-driven innovations, so the complicating factor of dealing with hardware and software—with its various interfaces—wasn't even a contributing problem in those studies showing problematic change efforts.

A BACKWARD SUMMARY

So we are sobered by our glance backwards. If we are optimistic, we can say, "Well, we're more sophisticated now. We can learn from problems of the past." The pessimists would say, "Human nature doesn't change. We may learn what happened, but we can't overcome the constraints faced by the sites and participants in the earlier innovation attempts." Warren G. Bennis [8] provides a sobering and cautionary view by saying that to change an organization changes must occur in relationships and organizational systems: "The only viable way to change organizations is to change the systems within which people work and live. A 'culture' is a way of life, a system of beliefs and values, an accepted form of interactions and relating."

This explains Pincus's [9] finding that innovations are not implemented as prescribed. Pincus gave three reasons for the fidelity-to-the-model failure of many innovations: (1) the researchers and developers do not provide enough guidance for implementers; (2) teachers and administrators do not accept the "obligation to change their behavior patterns"—changes that may be essential to implement the innovation; and (3) schools may not know how to adopt innovations—the strategies, the compromises, the collaborations, the reflectiveness required may not be part of the school's culture. These factors certainly have an intuitive resonance. We can all remember innovations where goals were vague or when the specific classroom practices were not spelled out explicitly. We all know of educators who choose a limited role, if at all, in supporting wave after wave of innovation, and we've all watched schools grapple unsuccessfully with demands for change, without support for change.

Rivlin [10] was more optimistic than Pincus. She said that if we pursue a rational evaluation policy we will learn from the process. Looking backward at the failed innovations of the 1960's and early '70's Rivlin said those failures occurred "because programs were not designed so we could learn what was effective and what was not." She said, for example, that analysts couldn't find inputs that were related to outcomes and said poor experimental designs were at fault. In her view, government should organize, fund, and evaluate large scale assessments of educational innovations. Rivlin's rational approach also resonates for us—surely if we do a good job setting goals and setting up the evaluation, all will be well.

But House [11] cautions us that rational models such as those proposed by Rivlin don't always produce the intended results. Basing his observations on his own experience evaluating educational innovations, House said, "One should tamper with a social system . . . only after more than a superficial understanding of the system itself and even then only with considerable trepidation. Otherwise, one is likely to propagate not only unproductive, but counterproductive, even harmful policies." Those of us who have seen good teachers lose confidence when problems in implementation occur can second House's concern. Those of us who have seen the school or district-as-a-social system revert to business as usual midway through an innovation can second House's concern—innovation is not always rational. But how will the billions of dollars heading our way deal with this?

House recognized that an innovation does not occur in a straightforward fashion. Sometimes even the best intentioned innovation causes disruption—probably because, as Pincus said, the school may be unaccustomed to innovation. He also recognized, as Bennis did, the paramount role imposed by cultural determinants. "There is an implicit order in American society—the order of institutions," said House, "and the schools do not exist freely outside that order; they are an integral part of it. Education can deviate only in the direction and to the extent that society allows." So, if society has pre-conceived ideas of what schools should do and technology visionaries have ideas that look or feel different, whose ideas prevail? Will the "Does it get my child into Harvard?" syndrome subvert teachers' attempts to use problem-solving software instead of drill? And will teachers' ideas-at-work deform software to conform to their "back-to-basics" ideas of teaching as happens in so many uses of HyperCard?

LOOKING FORWARD: WHAT WILL SOCIETY ALLOW OR DEMAND?

Earlier, we cited five problems facing schools. Consensus about how to resolve those problems is difficult to achieve—witness the need for seven different models of Follow Through to accommodate the differing educational beliefs-at-work of early childhood educators.

The problem of achieving consensus cuts across every income level, every state, and every type of school. So it is possible that a national directive, while necessary, may not be sufficient to meet the challenges pointed out by critics and commentators on the computer revolution. For example, not every teacher, administrators, or parent shares the vision of using computers for problem solving, simulations, and database use. As many are skeptical about changing the curriculum as are in favor in changes fostered by the computer revolution and envisioned by future-watchers—drill is more popular with computer-using educators than more open-ended activities. Anyone who challenges the dominance of drill in American schools must confront the data—standard textbooks (emphasizing the "basics") sell better than the so-called supplementary materials that teach problem solving, logic, probability, and statistics. They must confront the data showing that sales of Instructional Management Systems (IMS software) presenting drill in the "basics" are far greater than sales of simulation, problem-solving, and "creativity" software. They must think about data showing that disadvantaged students work on drill while more affluent students work more with problem-solving software. If what is bought reflects what people believe in, then drill in the basics is where the action is in American education, on or off the computer.

Even teachers who are currently using technology say that they have little time, little equipment, and few models for continuing change. They usually must train themselves and act as cheerleaders to win the participation of their colleagues. Many teachers' beliefs-at-work say that urban students should use drill and girls should experience different computer activities than boys. Thus we have an implicit national agenda. In many schools, that implicit agenda is the culture of the school—what has been done will continue to be done, computers or no computers. It is that point of view that the modern-day cautionary media voices are directed to.

So we have a potential conflict between the goals of those who view the computer revolution as an opportunity to advance students' higher order thinking and those who see classrooms where teachers coach students and students call up databases or use micro-based computer labs or problem-solving software for mathematics versus those who believe the business of education is to conduct the curriculum as usual. The implicit agenda is no different from the agenda in force when the New Math, BSCS, ESS, and a host of other innovations were proposed and tried during the 1960's and '70's. Although we may have learned how to conduct more sophisticated evaluations and we may have developed better instruments to measure change, if the conditions supporting change are not present—and, in fact, if the conditions run contrary to the goals of change—caution, not optimism is the watchword for the computer revolution. The presentation of a national agenda for school-based computing may reap the benefits of Follow Through. But then again, the dreams of computer visionaries may be as ephemeral as the dreams of the developers of SMSG, BSCS, ESS, and other projects.

Even more disturbing, failure to sustain the vision for computers in the schools may create an "I told you so," backlash. The computer as a tool may be devalued if we ask administrators and teachers whose beliefs-at-work run counter to proposed uses of computers to use computers in the ways we've tried to bring about. What these skeptics or reluctant innovators need is many forms of assistance:

- Visual models of what proposed changes entail. Skilled teachers and administrators, whatever their beliefs, will understand teaching in progress when they see it. As they observe the impact of different methodologies on students' classroom performance they can appreciate the merits of change and begin to understand the mechanics of change. Efforts to expand computer use must surmount the problems faced and not solved by earlier innovators—training must target how classrooms using technology should work and how to achieve the changes needed to attain the vision.

- Convincing data from convincing sources on the po itive and negative impact of computers. Skilled teachers and administrators appreciate the fact that changes in students' skill levels are worth pursuing and that the innovations that generate those changes are worth examination. Efforts to expand computer use must show teachers and administrators should actively demonstrate how students positively benefit from technology use.

- Concrete evidence that sufficient resources—available long-term—will be provided must accompany change efforts. This means staff development activities, materials, hardware, release time, mentors, and a host of other resources must be detailed, provided, and must be credible. Any blueprint for expanding technology-in-the-school use must include realistic, not "shoestring," budgets to support change.

- A structure whereby the federal government provides realistic fiscal resources, clearly targeted problem-solving-oriented consulting, and well-constructed formative evaluation. There should be a provision for data sharing and site to site consultation before, during, and after the initial stages of the projects. This means a structure that does not add more bureaucracy, but instead provides expertise from experts in the field. We do not need more bureaucrats filling more chairs in more rooms in Washington, DC.

Lest these cautions sound superfluous, I suggest a review of *Unlearned Lessons*, Barbara Presseisen's (12) review of the reform reports that made a splash in the 1980's. More than ten years later the recommendations that focused on resources needed for change have been virtually ignored while the recommendations to "toughen up" have attracted acclaim. The process of reform she recommended has yet to receive the funding or the critical review such major educational turning points require. All of the projects in our retrospective glance provided glimpses of the problems which persist—and which the reform efforts were designed to improve. So our caution about the likelihood of wide-scale commitment to the goals of technology visionaries deserves repeating. Given the funds targeted at introducing, expanding, and institutionalizing technology in schools—over $10 billion dollars in federal and private funds—and the increased bureaucracy attached to the disbursement and supervision of these funds, it behooves us to take a caution from the past while planning for the future. We can't be sure that $10 billion allocated will ensure success. The report of the expert panel for the review of federal education program in science, mathematics, engineering, and technology, for example, in criticizing federal management of programs already in place said, "The Federal Government cannot continue to spend large sums of money without knowing if its programs are accomplishing their established goals—or if these goals address national needs in SMET education." (13) The money must be targeted at problems identified while supplying solutions based on what we can learned from the cautions of the past. Above all, we must monitor what we do as we do it to ensure we are spending wisely and well this time around. Above all, we must pay attention to the complex impact the culture of the schools will exert to resist change.

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