

Technology and School Restructuring: Some Clarifying Propositions¹

Michael Molenda
Associate Professor
Instructional Systems Technology
Indiana University

Since A Nation at Risk was issued in 1983, a plethora of national reports have called for changes in the American educational system. Many proclaim the need for "reform of our educational system in fundamental ways," as did the original National Commission on Excellence in Education. The diagnoses rendered in that report and others like it do not ring true, though. Ultimately, they propose piecemeal remedies, each focusing attention on different issues at different levels within the system. Some focus on curriculum, others on teacher training, selection, or reward. Others focus on management of the school or the district; still others see school funding mechanisms as fundamental. Surely there is room for improvement in all these elements; but which are necessary or sufficient to attain the ultimate goal of building a system appropriate for our national aspirations? Might a more systemic vision help us find our way through the complexity?

The purpose of this paper is to examine the problem and possible solutions by means of a series of propositions, each of which can be seen as a hypothesis amenable to logical or empirical analysis. If successful, these propositions will clarify the argument and permit a more fruitful dialogue about a resolution.

THE PROBLEM AND ITS CONSEQUENCES

1. The public education system, designed in the 19th Century and modified throughout the 20th Century, no longer adequately serves the current or future educational needs of the nation (the *effectiveness* issue).

This proposition is accepted by most of the critics, although they may disagree as to the precise nature of the shortcoming; some criticize the curriculum, some the methods, some the organizational structure, some the funding mechanisms, and so on. For the moment, it is enough to agree that the results of the current system—the sum total of the abilities of its graduates—do not meet the nation's requirements. Reigeluth² and Goodlad³, among others, demonstrate

¹ © 1992, Michael Molenda. To be published in Educational Media and Technology Yearbook 1992, Englewood, CO: Libraries Unlimited, 1992.

² Charles M. Reigeluth, "The Search for Meaningful Reform: A Third-Wave Educational System," Journal of Instructional Development 10:4 (1987), 3-26.

convincingly the gap between modern societal needs and the capabilities of the old industrial model school.

Not only economic life has obsolesced the school of the 19th Century; social and demographic factors are also at work. Schools no longer primarily serve the white, middle-class, agricultural, two-parent household for which they were designed. Demographic projections tell us clearly that the trend toward diversity will accelerate into the future.

We need not take sides in the debate over whether public schools are getting better or worse. The position here is that they do not serve our societal learning needs adequately (on the average) and that they are not getting better fast enough (on the average) to cope with rapidly evolving demands.

2. The success of a nation's education system has profound consequences for its economic prosperity, its domestic tranquility, even its security.

Again, most critics accept this proposition. Perhaps the case is made best by Reich in his analysis of global economics⁴. He points out that "the standard of living of a nation's people increasingly depends on what they contribute to the world's economy—on the value of their skills and insights." That is, the crucial national resource for the coming era is "human capital."

3. The cost of operating the public education system is too high in relation to benefits (the *efficiency* issue).

American education, based as it is on the primitive factory model of the turn-of-the-century, suffers from many of the same inefficiencies as the old smokestack industries—dependence on labor-intensive methods, hierarchical layers of bureaucracy, inappropriate division of labor, failure to achieve economies of scale. In an era of unparalleled prosperity and limited global competition, as prevailed in America at mid-century, these inefficiencies were tolerable both in business and in education. They have long since ceased to be tolerable in business; they have become intolerable in education as well. Education news these days is dominated by stories of school district bankruptcy and crippling budget deficits, leading to cutbacks in programs—especially in "marginal" areas such as music, art, and athletics, increase of class sizes, even teacher layoffs.

ANALYSIS OF THE PROBLEM

³ John I Goodlad. A Place Called School: Prospects for the Future (New York: McGraw-Hill, 1984).

⁴ Robert B. Reich, The Work of Nations (New York: Alfred A. Knopf, 1991).

If the first three propositions are accepted, we acknowledge that there is a problem and that it is serious enough to warrant attention. Now we attempt to locate the heart of the problem.

4. Learning achievement is *the* crucial product of the educational system.

Schools obviously attempt to perform many functions in American society, including socialization of youth into the community. However, the primary and *unique* requirement expected of the schools is the attainment of the knowledge, skills and attitudes specified by state and local boards of education. Not only is that what is *legally* expected of schools, it is what Reich and others insist is the *vital* element for economic survival.

5. Research indicates that learning achievement is directly affected by several causative factors; these can be summarized as aptitude, effort, and instruction.

Walberg has been sifting prior educational research as well as conducting his own studies in his quest for a theory of educational productivity. His team of investigators conducted quantitative syntheses of nearly 3,000 investigations of productive factors, and they probed the significance of these factors in large sets of national data on learning achievement (such as the National Assessment of Educational Progress). In 1984 he reported a major synthesis of this research in Educational Leadership⁵. His overall conclusion: "the major causal influences flow from aptitudes, instruction, and the psychological environment to learning." He identified nine specific factors that appear causally linked with educational productivity:

Aptitude

1. Ability or prior achievement, as measured by the usual standardized tests;
2. Development, as indexed by chronological age or stage of maturation;

Motivation

3. Motivation, as indicated by personality tests or the student's willingness to persevere intensively on learning tasks;

Instruction

4. Amount of time students engage in learning;
5. Quality of the instructional experience, including psychological and curricular aspects;

Environment

6. Home, including school-parent cooperation, graded homework, and family socioeconomic status;

7. Classroom social setting—morale, cohesiveness, goal direction, and other classroom

⁵ Herbert J. Walberg, "Improving the Productivity of America's Schools," Educational Leadership 41:8 (May 1984),19-27.

climate factors;

8. Peer group outside school;
9. Use of out-of-school time, particularly television viewing.

In order to examine the interrelationships among these and other factors, they have been combined in a visual model (Figure 1).

[Insert Figure 1 here.

Caption: Factors Causally Related to School Learning Achievement]

This visual model can be used to analyze many of the criticisms made of educational practices and various of the claims made for proposed reforms. It demonstrates graphically that only three factors have a direct effect on school learning achievement: aptitude, effort, and instruction; interventions made elsewhere in the system can have an impact on learning *only to the extent that they influence aptitude, effort, or instruction*. For example:

- Class size (an element of Classroom Environment) affects learning indirectly in that large class size contributes to a depersonalized climate, depressing motivation, which decreases effort, and it biases the selection of instructional methods towards those that are large-group-based.
- Self-contained classrooms (an element of School Organizational Structure) influence learning indirectly by biasing the selection of instructional methods toward those that are passive and large-group-based.
- Norm-referenced standardized tests (an element of School Organizational Structure) influence learning indirectly by depressing aspirations of low scoring students, thus inhibiting their effort; they also bias instructional methods and content toward lower-level cognitive skills.
- School System Organizational Structure reforms, such as site-based management or parental choice of schools, can only influence achievement to the extent that they change school structures in a way that improves the classroom environment and influences instruction and effort. That is, site-based management itself does not improve student achievement; it may be a useful reform if it and when it creates better motivational and/or instructional conditions.

6. Some of the factors that influence learning are largely beyond the control of the school.

First, the factor most strongly correlated with school learning achievement is aptitude. Aptitude is highly dependent on genetic endowment and prenatal and early childhood care. These determinants are largely beyond the control of schools. However, schools can provide

classroom environments and can work with parents to create home environments characterized by physical and emotional well-being that encourage students to *activate and use* the aptitude they possess.

Similarly, motivation to invest effort in learning and having a positive self-concept are shaped more by home and out-of-school peer environments than by in-school influences. Schools can, however, complement and supplement out-of-school influences through provision of motivating classroom environments and use of instructional methods that promote interest.

Other influential factors over which the school has little control are family socioeconomic status, out-of-school peer group, and use of out-of-school time, particularly television viewing.

7. Schools have complete control over one factor that directly affects school learning achievement—instruction.

If schools are to improve their educational productivity they must focus their efforts on *instructional* factors, their "best wedge" into improvement of student performance. This means, at least, increasing the amount of time spent on task and exposing learners to more relevant curricular content instantiated in more powerful methods.

8. Schools have partial control over a factor that directly affects school learning achievement—effort.

The home environment and out-of-school peer environment have major influence on motivation to expend effort, but schools can reduce some of the demoralizing influences promoted by current practices: a) norm-referenced testing has demoralizing consequences for many students, immediately in terms of self-concept, later in terms of willingness to invest effort, ultimately in terms of dropping out of school; b) the depersonalized institutional climate characteristic of large schools engenders anomie in both students and staff.

9. Instructional processes flow out of and are constrained by the organizational structure of the classroom, school, and school system.

Heinich's work amply demonstrates how the base of the educational system—the certified teacher and the Carnegie unit—determines the superstructure that has evolved to support the base—self-contained, grade-level classrooms—which in turn biases the instructional methods employed⁶.

⁶ Robert Heinich, "Restructuring, Technology, and Instructional Productivity," in Gary Anglin (ed.), Instructional Technology Past, Present, and Future (Englewood, CO: Libraries Unlimited, 1991).

Many other analysts, including mainstream educational researchers, have begun to acknowledge the correctness of Heinich's diagnosis. For example, Linda Darling-Hammond commenting on recent federal proposals to establish "national goals:"

Essentially, this line of thinking assumes that problems exist either because educators don't have precise enough targets to aim for, because they aren't trying hard enough, or both....However, mounting evidence indicates that the assumptions underlying such thinking are flawed. The problem is not that schoolpeople lack direction and will, but...that they work within a *dysfunctional organizational structure* that has made inadequate investments in the knowledge and tools they need to address students' needs⁷.

Schlechty, a school administrator, comments along the same line:

The problem is that the concept of the graded class and the Carnegie unit have both become so enshrined in law, policy, custom, and regulation that the structures which support these conventions are almost impossible to change⁸.

SPECIFICATIONS FOR RESOLVING THE PROBLEM

If the above propositions related to the nature of the problem are correct, what features should be sought in an improved educational system?

The Effectiveness Problem

10. Student motivation and teacher morale can be enhanced by adopting a wholesome school organizational structure.

People perform more effectively when their work encompasses whole tasks, they have meaningful control over the means of achieving their goals, they have input into organizational issues, they see concrete results of their work, and when successful, high quality performance is recognized and rewarded.

Both for the sake of individual development and of societal well-being, learning should

⁷ Linda Darling-Hammond, "Achieving our Goals: Superficial or Structural Reforms?", Phi Delta Kappan (December 1990), 286-295.

⁸ Phillip C. Schlechty, Schools for the Twenty-First Century (San Francisco: Jossey-Bass, 1990), p. 65.

take place in a humane environment. Humaneness is learned through example and practice; respect for oneself and others grows out of a process in which learners are treated humanely.

11. The content of the curriculum should both reflect socially valuable skills and enhance the full range of intrinsic capabilities of humans.

Reich⁹ argues that the economic fates of Americans are beginning to diverge and that those who will prosper in the future global economy are those with "symbolic analyst" skills. This is consistent with many other voices within the Education community who advocate higher-level thinking skills as the paramount objectives for schools. The sub-skills of "symbolic analyst" include abstraction, systems thinking, experimentation, and collaboration.¹⁰ A curriculum to develop these sub-skills would be the opposite of the narrow, technical, subject-matter-mastery emphases of the "back to the basics" movement.

Looking at the fulfillment of human potential as a guide to the curriculum, Howard Gardner's theory of multiple intelligences would push us toward schooling experiences that promote the development of logical-mathematical, linguistic, musical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal skills¹¹ rather than the current curriculum, heavily skewed toward linguistic, mathematical, and logical skills.

12. The process of learning should be an active one in which learners have the chance to construct meanings from encounters with whole, realistic problems set in a social context.

The "cognitive revolution" has led to a new consensus among educational psychologists as to the nature of the learner and the learning process. According to this view, the dominant theory enshrined in school practice—the "transmission" theory which emphasizes well-structured presentations of material through lecture, demonstration, and recitation—is deeply misguided. "Instead," according to Pea and Soloway, "we now see that new learning is *constructed* in terms of prior knowledge by an active learner in a social context, that knowledge is best acquired in functional contexts...."¹²

⁹ Reich, op. cit., p. 196.

¹⁰ Reich, op. cit., p. 229.

¹¹ Howard Gardner and Thomas Hatch, "Multiple Intelligences Go to School," Educational Researcher (November 1989), 4-10.

¹² Roy D. Pea and Elliot Soloway, "Mechanisms for Facilitating a Vital and Dynamic Education System," Educational Media and Technology Yearbook, 1990 (Englewood, CO: Libraries Unlimited, 1990), p. 36.

The pedagogical processes appropriate to this new view include immersing learners in realistic problems and guiding them through collaborative problem-solving using such techniques as small-group cooperative learning, peer tutoring, and apprenticeship learning.

13. Since assessment tends to drive curriculum and methods, assessment should be both criterion-referenced and based on demonstrated proficiency on authentic tasks.

Criterion-referenced assessment attempts to judge learner performance against a pre-specified standard or criterion rather than comparing the learner with other learners. Since different standards may be invoked for learners with differing abilities and interests, this view allows "every kid to be a winner," with the concomitant payoffs in self-concept and motivation for continued exertion of effort.

There is widespread consensus that rather than paper-and-pencil tests, better indicators of mastery of higher-order skills are direct observations of performances such as story-telling, drawing, constructing, and problem-solving. Evidence gathered through such observations would be collected in a portfolio. Issues of validity, reliability, and feasibility remained unresolved at this time, however.

14. Instructional methods and organizational structures based on *individualization* are critical for major improvement in effectiveness.

Branson¹³ has presented a convincing case for the "upper limits hypothesis," that the existing school model has reached the upper limits of its perfectibility as indicated by the consistent findings of "no significant difference" when new methods are attempted. That is, schooling based on large-group instruction has been improved as far as it practically can be. To attain greater effectiveness will require abandoning the current design philosophy.

The futility of treating a group of 30 children as though all were alike in abilities, needs, interests, and responsiveness to a particular instructional modality is manifest when one considers the generally accepted rule of thumb that the range of student abilities in a given grade increases with each step up in grade; that is, if there is about one year of range at grade one, by grade eight there is an ability range of about eight years.

Demographic projections based simply on the numbers of children already born tell us that American schools in the coming years will be serving an increasingly diverse population in terms of ethnic and linguistic differences. Without a system better able to accommodate such differences one can only predict greater and greater failure rates.

¹³ Branson, Robert K. "Why the Schools Can't Improve: The Upper Limit Hypothesis," Journal of Instructional Development 10:4 (1987), 15-26.

Interestingly, one group of public school children is already legally entitled to individualized treatment—those who fit "special education" criteria. Teachers have found ways to prepare (and presumably deliver) "individualized educational plans" for handicapped children, thanks to federal legal strictures. Parents of "non-special" students are now beginning to ask why their children do not merit individualized attention.

Individualization, of course, is not to be equated with independent study. Individualized plans that respond to the range of curricular objectives, including social, attitudinal, and interpersonal ones, would necessarily provide a varied menu of independent study, tutoring, small-group interaction, and probably some large-group activities.

What would the organizational structure look like for a school committed to individualization? There is no shortage of models to choose from, either from the drawing boards of dreamers or from real-life prototypes: The Dalton Plan and Winnetka Plan of the past, Montessori schools, Waldorf schools, Dewey's University of Chicago Laboratory School, Goodlad's Nongraded Elementary School¹⁴, right up to the today's Saturn School in Minnesota. Key features are multi-age, non-graded units staffed by teams of professional teachers and non-professionals. Students move in and out of a variety of modes of instruction, some teacher-centered, some resource-based; individual progress is tracked and order maintained with computerized management tools.

John Goodlad's current vision¹⁵, for example, recommends small primary schools comprised of four "vertical" units of 100 students each. Each nongraded unit would contain 100 students with a four-year age span, with these students and a team of teachers staying together through that four-year phase. With the *equivalent* of four teachers available, a differentiated staff of one head teacher, one support teacher, and several aides and interns is possible.

The Efficiency Problem

15. Reducing labor costs through differentiated staffing is the most promising source of cost efficiencies.

Public education has been strikingly backward, compared to other sectors of the economy, in increasing its productivity. The key to the productivity gridlock lies in the labor-intensive character of elementary and secondary schooling. Indeed, labor costs consume up to

¹⁴ John I Goodlad and Robert H. Anderson, The Nongraded Elementary School (New York: Teachers College Press, original edition 1959, revised edition 1987).

¹⁵ Goodlad, A Place Called School, p. 329.

90% of the budget in many instances. A large chunk of the labor is devoted to staffing the enormous, multi-layered bureaucracies necessitated by the factory system. An even larger portion of the labor budget goes to support one certified teacher for each egg-crate classroom.

The temptation of budget-cutters is to preserve the current egg-crate system but make it cheaper by putting more students in each compartment—raising the pupil:teacher ratio. Teachers, protective of their own workload, lobby to reduce the pupil:teacher ratio. Neither side can conclusively prove that raising or lowering the ratio increases or reduces the quality of learning (as discussed earlier, class size itself has no direct effect on learning achievement). The result is stalemate, with budget-cutters winning in lean times and teachers winning in fat times, but no-one questioning the basic assumption of the egg-crate system.

However, many experiments in differentiated staffing have demonstrated that when students are redistributed in a nongraded system staffed by teams of professionals, paraprofessionals, nonprofessionals, interns, and volunteers, overall labor costs are held constant or reduced while educational results remain equivalent or improve¹⁶.

To probe further into means of increasing cost efficiency we must consider the possibilities of technology, the next major section of this analysis.

THE ROLE OF TECHNOLOGY IN INCREASING EFFECTIVENESS AND EFFICIENCY

Instructional technologists have long embraced Galbraith's notion of technology as "the systematic application of scientific or other organized knowledge to practical tasks." This view focuses on technology as a process—a way of thinking. However, most other educators think of technology only as products, the "things of learning"—computers, satellites, AV equipment, and the like. Recently, the product/process distinction has been highlighted by using the terms "hard technology" (products) and "soft technology" (processes). The roles of both hard and soft technologies will be elaborated here.

Effectiveness Tools

16. Soft technologies of instruction based on the behaviorist learning model (e.g. programmed instruction, programmed tutoring, mastery learning, Direct Instruction, and Personalized System of Instruction) have a well documented track record of success in terms of conventional measures of achievement.

There is a large volume of research literature composed of comparison studies in which

¹⁶ Schlechty, op. cit., p. 68.

various behaviorist-based treatments are compared with "conventional instruction" in terms of scores on end-of-term achievement tests. The results of meta-analyses of these bodies of research heavily favor the experimental treatments. An example is Ellson's meta-analysis of comparison studies in which an experimental treatment was more than twice as productive as the control treatment, that is, learning an equivalent amount in half the time or at half the expense.¹⁷ Among the 125 studies that met this criterion, Ellson found that about 70% constituted some variation on programmed instruction, programmed tutoring, or Direct Instruction.

Other examples:

a) Structured tutoring. Meta-analyses have found various forms of programmed or structured tutoring to be among the most effective and cost-effective innovations, with tutees scoring from the 70th to the 79th percentile compared to the 50th percentile for conventional instruction¹⁸.

b) Mastery learning. Mastery learning courses, generally in the form of Bloom's Learning for Mastery (LFM) or Keller's Personalized System of Instruction (PSI), "have positive effects on student achievement. On the average, such programs raise final examination scores...from the 50th to the 70th percentile, in colleges, high schools, and the upper grades of elementary schools."¹⁹

¹⁷ Douglas G. Ellson, Improving the Productivity of Teaching: 125 Exhibits (Bloomington, IN: Phi Delta Kappa, 1986).

¹⁸ Peter A. Cohen, James A. Kulik, and Chen-Lin C. Kulik, "Educational Outcomes of Tutoring: A Meta-Analysis of Findings," American Educational Research Journal 19:2 (Summer 1982), 237-248.

¹⁹ Chen-Lin C. Kulik, James A. Kulik, and Robert Bangert-Drowns, "Effectiveness of Mastery Learning Programs: A Meta-Analysis," Review of Educational Research 60:2 (Summer 1990), 265-299.

c) Personalized System of Instruction (PSI). In the first decade after Keller's invention of PSI some 75 comparison studies had been published. A review of these studies reported that the typical PSI student scored at the 75th percentile on a standardized test compared with the 50th percentile for the control treatment²⁰. A later review of PSI research found that student preferences also strongly favored PSI courses over conventional ones: "Students rate PSI classes as more enjoyable, more demanding, and higher in overall quality and contribution to student learning than conventional classes"²¹.

17. Soft technologies of instruction based on the cognitive and social-psychological learning models (e.g. simulation/games, cooperative learning, computer hypermedia modules) have demonstrated effectiveness both in terms of conventional measures of achievement and for higher-order thinking skills.

Techniques derived from cognitive and social-psychological views of learning typically aim for "understanding" or problem-solving capabilities rather than ability merely to perform successfully on paper-and-pencil tests. Consequently, the evidence for their success tends to be more anecdotal than quantitative. In any event, there is considerable evidence to support the effectiveness of these teaching-learning patterns. Some examples:

²⁰ James A. Kulik, Chen-Lin Kulik, and Beverly B. Smith, "Research on the Personalized System of Instruction," Programmed Learning and Educational Technology (Spring 1976), 13, 23-30.

²¹ James A. Kulik, Chen-Lin C. Kulik, and Peter A. Cohen, "A Meta-Analysis of Outcome Studies of Keller's Personalized System of Instruction," American Psychologist 34:4 (April 1979), 307-318.

a) Simulation/games. Szczurek carried out a meta-analysis of 58 experiments comparing instructional simulation games with conventional instruction with regard to cognitive learning. He found an average simulation game student scoring at the 63rd percentile compared to the 50th percentile for conventional instruction²². More qualitative evaluations are discussed by Megarry²³.

b) Cooperative Learning. Slavin has developed a number of instructional frameworks for cooperative learning, including Student Teams-Achievement Division (STAD), Team Accelerated Instruction (TAI), and Cooperative Integrated Reading and Comprehension (CIRC). He reports that 33 of 38 comparison studies show significantly greater achievement for the cooperative learning mode. Further, that "positive effects have been found on such higher-order objectives as creative writing, reading comprehension, and math problem solving, as well as on such basic skills objectives a language mechanics, math computation, and spelling"²⁴.

c) Computer hypermedia modules. Available only since the late 1980s, hypertext computer software provides a means for structuring information in a way that is parallel to the nonlinear associative nature of human thinking. Hypertext programs allow a learner to explore a database establishing links among ideas to form webs or conceptual maps meaningful to the particular user. These are referred to as hypermedia programs when text fragments, graphics, and video clips are all available to be perused, organized, revised, edited, saved, and shared among users.

Judgments about effectiveness are currently based on evaluative observations, but research and development to date show this to be a technology of great promise for "constructivist" learning, the sort promoted by the advocates of the cognitive revolution in psychology²⁵.

²² Mario Szczurek, Meta-Analysis of Simulation Games Effectiveness for Cognitive Learning, unpublished doctoral thesis (Bloomington, IN: Indiana University, 1982).

²³ Jaquetta Megarry, "Simulation and Gaming," International Encyclopedia of Educational Technology (Oxford, UK: Pergamon, 1989).

²⁴ Robert E. Slavin, "Cooperative Learning and the Cooperative School," Educational Leadership 45:3 (November 1987), 7-13.

²⁵ A vivid example of the possibilities of hypermedia learning is provided in Theodore W. Frick, Restructuring Education Through Technology (Bloomington, IN: Phi Delta Kappa Educational Foundation, 1991).

Efficiency Tools

17. Telecommunication systems (e.g. radio, television, teleconferencing) can effect cost savings by sharing instruction among multiple sites.

In recent years it has become advantageous to use telecommunications to share teachers among multiple school sites through interactive television. The impetus came from schools that were not able to support teachers in specialty areas but needed courses in those areas to retain accreditation. Services such as TI-IN Network sprang up in Texas but now reach high school students in dozens of states. Other regional consortia have been supported by the Star Schools program initiated by the U.S. Department of Education. Taken together, these two-way video, one-way audio television courses reach over 100,000 students in 45 states.

In poorer countries radio serves a similar function—sharing a master teacher among dozens of schools. In Nicaragua, Kenya, Honduras, Papua New Guinea, and other countries a pseudo-interactive format is used, in which the broadcast radio lessons include embedded questions and pre-recorded feedback to the learners' responses. Evaluations indicate that children respond enthusiastically to these programs and that they learn: children in the radio treatment score at the 69th percentile compared to the 50th percentile in the control treatment²⁶.

In all these cases, the mediated course is used unabashedly in place of a live teacher. The investment in hardware and program development is justified on the basis of savings derived from avoiding hiring additional personnel.

18. Resource-based delivery systems (e.g. integrated learning systems, self-instructional modules) can effect cost savings by substituting for human-based delivery.

"Integrated Learning System (ILS)" refers to computer-based courseware packages that contain multi-year curriculum sequences. Wicat Systems, Computer Curriculum Corporation, and Jostens Education Systems Corporation are some of the commercial vendors that are developing and installing computer-based systems to cover entire curricula. Student users receive individualized instruction and can progress at their own pace with evaluation sometimes based on computer adaptive testing. Vendors match their ILS lessons to local curriculum objectives, so they may be on a low or high cognitive level depending on local objectives.

Of course, this sort of resource-based instruction was conducted generations ago—all the way back to the first quarter of the 20th Century—by means of printed self-instructional modules. The difference is in the degree of interactivity now possible through computer mediation. With

²⁶ Maurice Imhoof and Philip Christensen (ed's), Teaching English by Radio (Washington, DC: Academy for Educational Development, 1986).

the advent of expert systems, it is now even conceivable that ILS lessons could adapt to a wide range of learner styles.

WHY RESTRUCTURING IS REQUIRED

19. Technology can make major contributions to the effectiveness and efficiency of instruction but to make sense economically the costs of technology must be self-liquidating, as they are in business and all other participants of the market economy.

20. In order to become self-liquidating, technology must replace costly human labor to some extent; this threatens the interests of those now doing the labor.

In order to become self-liquidating, technology must be viewed as a productivity enhancer. This means replacing and/or amplifying human labor in some way, shape, or form. As such, as Heinich points out, technologies threaten power relationships within the organization and "as technology becomes more sophisticated and more pervasive in effect, consideration of its use must be raised to higher and higher levels of decision making"²⁷.

Shrock predicts that

We can anticipate that teachers comfortable with their traditional role in the

classroom will suppress any technology that threatens that role.

Unfortunately, the traditional role preferred by most teachers—teacher centered, large group, expository, text supported teaching—is largely incompatible with the recommendations of instructional technologists (and the results of educational research).²⁸

21. Schools must be thoroughly restructured to use technology wisely and well.

As Doyle points out, most educators see technology as a costly add-on, similar to a car radio; it doesn't affect performance or direction but makes getting there more pleasant²⁹. This proposition brings us back to the earlier Proposition #9 related to the organizational structure of

²⁷ Robert Heinich, "The Proper Study of Instructional Technology," Educational Communication and Technology Journal 32:2 (1984), 67-87.

²⁸ Sharon A. Shrock, "School Reform and Restructuring: Does Performance Technology Have a Role?" Performance Improvement Quarterly 3:4 (1990), p. 25.

²⁹ Dennis P. Doyle, "The Challenge, The Opportunity," Phi Delta Kappan (March 1992), 512-520.

the classroom, school, and school system. In order to be put in place and to take root, technological innovations are contingent upon fundamental changes in the legal and organizational superstructure that supports the entire educational system.

In summary, the main points made in these twenty-one propositions are that: 1) public education must become more efficient and effective in achieving its goals; 2) learning achievement is the crucial goal of schools; 3) learning achievement can only be affected by instruction, effort, and aptitude, and of these, instruction is most fully controllable by the school; 4) interventions such as site-based management or parental choice of schools contribute toward improvement *only* to the extent that they affect instructional practices; 5) both hard and soft technologies can have major impact on school effectiveness and efficiency; and 6) for technology (or other interventions) to have a strong and lasting impact, the system must be thoroughly restructured.