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ABSTRACT

The critical issue discussed in this document is the extent to which changes now occurring in the field of education--in state laws, administrative actions, and educational practice--are informed by valid research and experiences. Questions are raised about the adequacy of the informational base of the main reports on excellence and reform, and the role of research in assisting policymakers and educators as they carry out legislative mandates to improve the schools. To examine these issues, papers were commissioned from authorities in three fields: (1) improving teacher incentives and the quality of teaching; (2) the case of dropouts as a possible mismatch between excellence and equity; and (3) teaching and learning higher-order thinking skills in the schools. This report summarizes the nine authors' assessments of the applicability of research in their specialities to the reports on reform and relevant actions around the country. In varying degrees this paper demonstrates that the links between research, policy, and action in the reform movement Have been less than ideal. (JD)

ITEMS FOR AN AGENDA

Educational Research and the Reports on Excellence

American Educational Research Association
Washington, DC
1985

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Single copies of the primary papers on which this report is based (listed in "Acknowledgments") are available on request (while supplies last) from the American Educational Research Association, 1230 Seventeenth Street, NW, Washington, DC 20036.

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Acknowledgments

The primary content of "Items for an Agenda" comes from the following papers which the American Educational Research Association commissioned as part of a U.S. Department of Education-supported grant on research contributions for educational improvement:

Ann L. Brown
"Teaching Students to Think as They Read: Implications for Curriculum Reform"

Philip A. Cusick
"The Effects of School Reform on the Egalitarianism of the Schools"

Stephen F. Hamilton
"Raising Standards and Reducing Dropout Rates: Implications of Research for Recent Secondary School Reform Proposals"

Virginia Koehler
"Inside the Classroom"

Edward L. McDill, Gary Natriello, and Aaron M. Pallas
"Raising Standards and Retaining Students: The Impact of the Reform Recommendations on Potential Dropouts"

Milbrey McLaughlin
"The Limits of Policies to Promote Teaching Excellence"

Frederick Reif
"Teaching Higher-Order Thinking Skills for a Technological World: Needs and Opportunities"

Marlene Scardamalia
"Higher Order Abilities: Written Communication"

Philip C. Schlechty
"Restructuring the Teaching Occupation—A Proposal"

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American Association of School Administrators
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Council of Great City Schools
National Association of State Boards of Education
National Education Association
National School Boards Association

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Research and the Reform Reports

Reports on educational reform will not reform education. As messengers of knowledge and insight, they can only signal needs and inform decision-makers of actionable choices. The job of prescribing and disciplining reform in all its diversity is up to the governors, legislatures, and school boards who wield political power. How they interpret the issues will be decisive in determining whether schooling will attain excellence in America.

The process of change is off to a fast start throughout the country. It promises to be a bumpy and uneven business, though, with wide variability in practice and in the availability and application of reliable information. Some of the most powerfully motivated promoters of change consistently overlook valid data and disregard institutional memory in their quest for higher educational quality. To ignore relevant research findings is to risk costly misunderstanding about students, teachers, schools, and the links between schools and society that affect change where it must occur—in the smallest units of the educational system.

As reform proceeds, there is a continuing gap between what research can provide and what is happening or about to happen in several key areas. Reform-oriented policies and their implementation in the schools may in time cause as many problems as they solve on two counts where there is already ambivalence and debate: (1) the matter of protecting and promoting equity during and after the search for excellence, and (2) the chronic sore spot of assessing accurately whether and how policies promoting change are working. Yet these two issues affect nearly every facet of reform.

The catalogue of exhortations and recommendations in the reform reports is replete with policies and actions that could use markedly better information. In this document the American Educational Research Association spotlights three subjects in which already available research data and analysis may assist planners of current and future efforts at reform for excellence: (1) improving teacher incentives and the quality of teaching, (2) the case of dropouts as a possible mismatch between excellence and equity, and (3) the generally neglected issue of teaching and learning higher-order thinking skills in the schools.

Options for Teachers and Teaching

Of the several bumper crops of reports on educational reform of 1983–1984, none has found a readier market in state legislatures than teachers and teaching. Portrayed as constituting a near-disaster area in education, the recruitment, performance, work habits, incentives, preparation, and quality of teachers have ignited attention and action throughout the nation. Scarcely a week passes without legislative or executive measures aimed at achieving excellence in the teaching profession and the services it provides school age children. Overdue and widely welcomed, the gathering force of reform in pedagogy has become a front-burner issue in education, especially in state capitals and among responsible educators.

This burst of debate and activity, which accounted for more than 700 pieces of state legislation in 1983 and 1984, is healthy, and it promises, at least in the short term, to be productive. Less certain, however, is the extent to which it is informed. The opening assumption that things are bad may be valid, but it frequently comes accompanied by a mind-set against teachers that contributes little to a deeper appreciation of the real problems of their profession. Too, the cumulative effects of the changes in policy and practice that are making their way through legislatures and state agencies may be to constrain or bureaucratize the role and status of teachers and teaching. In the long run, it is doubtful that any reform will work that does not, instead, ultimately enrich, enhance, expand and empower them. Moreover, unless such reform embraces the entire system of which teaching is part, it is unlikely to have much chance of success.

Although educational research cannot tell policy-makers what to do, it has contributed sizeably to informing them of the phenomena and problems of teaching. As reform moves from exhortations to laws and practices, however, there is a continuing need for decision-makers to possess an even clearer sensitivity to certain intrinsic forces and factors affecting the realities of teaching. Central to any impending changes must be a firm appreciation of, among others, who and what the teacher is and does, the premises and limits of policies to promote excellence in teaching, and the political-bureaucratic-structural problems of the profession.

What and Who a Teacher Is

To understand what education is all about is to understand about teachers teaching children in classrooms. No reform can succeed, or even proceed, unless decision-makers have firmly implanted this truism in their approach to change. Yet, today's main prescriptions for reforming the profession (or art, craft, occupation, quasi-, semi-, or non-profession) of teaching have come from outside the classroom.

There seems little justification for the nearly total exclusion of practitioners in any field from policies and decisions that directly affect them. Perhaps the problems of formal education, an experience in which all Americans have a strong investment, are so well known, like those of politics or sports, that professional counsel or involvement by insiders is extraneous. Whatever the reason, teachers have never achieved any serious control over their own destiny, while doctors, lawyers, and countless others maintain a firm grasp on the business of their businesses.

Public perceptions of teachers and teaching are a maze of contradictions. Teachers are poorly paid, but they should be more proficient in their work. Classes are huge, but children should receive more individual attention. Students should be kept under closer disciplinary control while violence in the larger society and on television becomes epidemic. Student test scores have fallen or are drifting, but "lay-ons," externally imposed demands (such as programs dealing with the single-parent student) that have few links to substantive education, force teachers to reduce instructional time. The list continues. So will public confusion until firm, commonly held information regarding this vital profession gains acceptance.

A hypothetical want ad (by Linda Darling-Hammond of the Rand Corporation) for a teacher sets forth the following requirements:

> College graduate with academic major (master's degree preferred). Excellent communication and leadership skills required. Challenging opportunity to serve 150 clients daily, developing up to five different products each day to meet their needs. This diversified job also allows employee to exercise typing, clerical, law enforcement, and social work skills between assignments and after hours. Adaptability helpful, since suppliers cannot always deliver goods and support services on time. Typical work week 47 hours. Special nature of work precludes fringe benefits such as lunch and coffee breaks, but work has many extrinsic rewards. Starting salary $12,769, with a guarantee of $24,000 after only 14 years.

This thumbnail sketch is too close to the bone for comfort. It nevertheless tells only part of the story. Although it is fashionable to denigrate teachers, "teacher-bashing" having become a favorite indoor sport of the 1980's, expectations for them in at least six basic areas are endless. By most accepted criteria, they are *executives*, *managers*, *communicators*, *colleagues*, *inquirers*, and *clerks*. Their daily responsibilities within each category range from the rational to the ridiculous and back again. In each of the six, they perform manifold expanding functions. Unlike their approximate opposite numbers in fields outside of education, they are considered to be fully equipped and credentialled professionals, ready to meet the most exacting demands of their profession, from their first day of

work. Only seldom, and for brief periods, do they receive training to improve or maintain their skills at externally prescribed levels. But society expects them to make informed daily judgments that may bear heavily on the future of its children. What worked a generation ago, in a classroom almost identical to today's, presumably should work forever.

Beyond the illusory stability of the classroom, which only superficially has remained the same, lie new combinations of pressures to complicate the life of the teacher. Of these probably the most salient is the shift in the composition of students in the classroom. New populations created by the obligations of laws concerning desegregation, mainstreaming children with handicapping conditions, and bilingual education have altered the demographic profiles of once-homogeneous classes. More students are staying in school longer than in the past, while potential dropouts, especially in the higher grades, demand special attention. Specialists such as reading experts, special educators, and speech pathologists draw students away from the classroom throughout the day. Teachers must now compete with television and after-school employment, which is particularly attractive and diverting for high school-age students.

This mixture of externally mandated factors bedevils some teachers, but the greatly underrated majority takes them in stride, at least at the level of the elementary school. The literature on effective teaching reveals no fixed styles or instructional behaviors for good teachers. They work in low-income, urban mixed-income, suburban, and rural schools, and they come from a variety of cultural, social, and educational backgrounds. They approach teaching in different ways, with but one characteristic in common—an emphasis on reading and mathematics. In general, however, good teachers tend to do the same things well. They minimize noise and disruption. They accurately diagnose student skill levels and provide assignments appropriate to them. They maximize educational while minimizing social relationships with the students. Their carefully constructed questions elicit relatively high rates of correct answers. Once a task is completed, they provide immediate and thoughtful feedback. By minimizing time devoted to non-academic tasks, they are able to move swiftly from activity to activity. Appreciating that what they do as teachers makes a difference in the learning of their students, they expect and usually get creditable performance.

These indicators of good teaching have wide, but far from universal, applicability. They come from voluminous research in effective schools and classrooms and may vary depending on students, subject matter, grade level, and diverse working conditions. As a general rule, they form the underpinning of good inservice teacher training programs for elementary education. But there is additional evidence that cooperative learning and small group models are also effective,

notably in the acquisition of sophisticated thought processes (see "Higher-Order Skills and the Three R's," below) and enhancing social attitudes. What comprises effective teaching behavior in secondary school classrooms remains a matter for serious research. There is little available now.

The strongest influence on new teachers is their own past schooling and teachers. In no other occupation does personal experience—12 to 14 years of elementary and secondary school and exposure to many more teachers—have such a powerful effect. Preservice programs help to develop the instructional skills of new teachers, but the cooperating teachers preservice students encounter in practice teaching have more effect than college courses, although the latter are usually helpful. As their training progresses, students become less idealistic and more traditional, even custodial, in their view of their job. Experienced teachers are less concerned than newcomers about the backgrounds of their students, preferring instead to let performance speak for itself. They tend, too, to become more global and efficient in their thought processes.

Research on these and related matters is only beginning. It may prove important to both policy and practice. As states develop examinations for certification and criteria for evaluating beginning teachers, they should take into account these and other developmental differences between beginning and experienced teachers. Setting single, or universal, standards may prove to be unwise policy.

Policies to Promote Excellence

The locus of reform in teaching is shifting from the mandates that issue from legislative halls and governors' offices to the real world of teachers in the classroom. As the move proceeds, there is cause for concern over the suitability of some of the new policies that are rapidly making their way, more rapidly in many cases than their most ardent backers could have anticipated, into schools and classrooms. Do they truly result in effective service to students, which surely is a central norm and motivating factor for teachers? Are they accurately attuned to conditions in the workplace, which often constitute the key impediments to educational excellence? Are they creating such complicated mini-systems and sets of values that standardization will be impossible? Available evidence suggests that decision-makers would be wise to examine a broad cluster of mutually reinforcing conditions that explain much about the current conditions of teaching and the quality of classroom practice. These may prove to exert decisive influence over the execution of reform measures.

The institutional context of teaching offers strong clues to the potential feasibility of certain strategies of reform. No two classes or

schools function in precisely the same way. Within them, the teacher enjoys a disquieting autonomy—isolated from colleagues nearly all day but the beneficiary (or victim) of the traditional norm of "non-interference." Although criteria for good teaching have gained wide acceptance (see "What and Who the Teacher Is," above), at its core the job is a problem-solving activity that relies on the judgment and discretion of teachers in developing situationally effective responses. This built-in variability thus can be both problem and opportunity in that it can signal uneven quality in classroom practice while constituting a key ingredient of effective teaching.

Unevenness epitomizes other "institutional" aspects of the teacher's life in the classroom. Teachers have little professional status and a flat career structure that may offer intellectual and emotional numbness instead of the tangible incentives most fields can provide. Moreover, they have no voice in deciding whom they will teach. Public schools accept all who appear at the front door. There is no recall provision as in the case of automobiles. Prohibited in customary practice from either selecting or dismissing pupils, teachers daily face students of widely varying age, ability, behavior, and interest in class work.

How teachers react to reform initiatives may turn on considerations that are often absent from or weakly represented in policy debates on reforming their business. Usually conducted by outsiders, these deliberations seldom pay more than lip service to the primary sources of satisfaction and reward for teachers—service to young people and transmitting the knowledge of a particular discipline. Research attests that this type of internal incentive is even more effective than monetary rewards. But the reforms must yield positive results or teachers will resist or be indifferent to it. Change that teachers feel competent and safe to undertake, even to the extent of "unfreezing" long-held routines and beliefs, has a good chance of adoption. In the living world of bureaucracies, professional recognition, and cost benefit, teachers will refer to their own "practicality ethic." Will a given reform initiative work, and is it likely to wear well?

The planners of teacher reform have devoted only limited attention to the superficially simple but loaded questions of the readiness and ability of teachers to act on unfamiliar knowledge, promising practice, or external mandates. The acquisition of new skills, and sometimes of notably different attitudes or values, involves modifying deeply held views about "best practice" and relinquishing long-term beliefs about instruction. The process may prove unsettling unless competent, personalized technical assistance and sufficient time to absorb new information and methods are available. Teachers are initially unsympathetic to anything new that threatens to become a burdensome "lay-on" or which forces them to rearrange priorities.

When removed from the political arena and viewed against this backdrop of realities and apprehensions, the more noteworthy current designs for improving teaching appear to comprise roughly equal portions of good intentions and incomplete research.

- *Salary increases and merit pay* for teachers are on first impression standard American verities, and few teachers would or should knowingly reject either in an economy in which they are among the least favored of college graduates. But attrition is highest among the best paid in the profession, those who serve in inner city schools, where non-economic considerations take precedence over raises in salary. Nor is merit pay quite the incentive it appears to be. It vitiates "voluntarism" while forcing new, probably unverifiable, assessment criteria on teachers. Less obvious is the grave implication that teachers can arbitrarily, and frighteningly, choose to improve their work or withhold competent practice.
- *Proficiency tests*, which largely assess verbal ability and numeracy, are a serviceable tripwire to identify grossly underqualified teachers. The competencies they measure have little to do with excellence in teaching. Requirements that experienced teachers submit to them for recertification demeans good teachers, erodes their status, and incurs the resentment of those whose cooperation is mandatory if reform is to work.
- *Mentor teaching* schemes are tantalizingly attractive as career alternatives for the best teachers and as mechanisms to relieve the isolation of the teacher. They draw on locally available human capital to provide collegial support and constructive criticism to all, especially newer, teachers. These benefits notwithstanding, "mentoring" as presently structured may create serious problems of role justification and perception, duration, selection criteria, evaluation, and morale.
- *Career ladders* have the potential to remove the flatness from the occupational structure while creating new roles, responsibilities, and reward systems. They can help to build an institutional capacity in schools to support beginning teachers. Properly designed and administered, they can strenghten links between performance and remuneration in merit pay schemes and the peer-based assistance and support required in mentor teaching systems. They do not all work that way. Some career ladders are merely fancy dress for merit pay. Quotas and competition are often associated with movement up the ladder. The hierarchical nature of ladders sparks concern over time in grade, competition, and the nature of the added responsibility that normally accompanies advancement. And they do not account for the competent teacher in the trenches who wants only to achieve increased status as a teacher and not increased, possibly administrative, responsibility.

A common thread in all of these policies and designs for improving teaching is an implicit dependence on reliable, functioning systems for evaluating teachers. They need and value informed commentary on the quality of their work. Evaluation helps them to identify instructional practices worthy of sharing with colleagues. It can mitigate the effects of isolation by offering teachers the informed feedback that peers often supply in other fields. Creditable evaluation can support the "counseling out" of teachers ill-suited to the field. Principals must have it in order to promote the common goals of effective schools. Legislators, in particular, demand and are richly entitled to accountability.

It is no secret in the world of educational research that most existing methods for assessment consist of standard checklists and that they are based on limited observation of how a teacher performs. They will not work for these reforms. Teacher evaluation is a case study in how policy objectives and expectations can outdistance available practice and technology. It will not suffice for administrators to submit evaluation that stems from an "I know what I like" or "Keep up the good work" mentality.

Even if the shortcomings of the current reform initiatives in teaching were remedied, the extent to which they could promote significant improvement is questionable. Singly and together, they generally fail to summon up the incentives necessary for professional growth, and they neglect altogether the institutional setting in which improvement is supposed to materialize. They are only partial responses to complex, system-wide institutional problems at a time when piecemeal policies that attempt to mend this or that part of a major problem will not help much. Effective policy solutions must work in multiple, reinforcing, and, above all, systemic ways.

A Profession in Need of Systemic Reform

The worst-kept secret in American education may be the unimpressive academic abilities of the nation's newer teachers. While capable, strongly motivated teachers traditionally have staffed our schools, well-publicized recent research indicates that the assembly lines of teacher training are receiving and discharging less qualified successors. The more academically able college graduates are not flocking to teaching, and those who do choose it are less likely to stay than those who showed fewer academic skills in college. Equally ominous is the growing rate of turnover of beginning teachers, most markedly among academically able ones in such high demand areas as mathematics and science. To add to a disheartening picture, teaching is attracting a dramatically lower percentage of all college graduates than it did only 20 years ago. The decline is particularly pronounced among women and members of minority groups, for

whom broader career options have opened. Large categories of college-educated persons whom society once almost literally pushed into teaching—women and minorities, upwardly mobile men viewing teaching as a stepping stone to higher status positions, and values- rather than income-oriented persons—are drawn to other pursuits.

Talented people who enter teaching today do so out of a positive, even courageous, attraction to it in the face of severe competition from career fields that offer what teaching often does not: recognition, advancement in status, and career growth. It has become axiomatic that fundamental and significant alterations in the ways teachers are educated, evaluated, trained, motivated, and rewarded must occur if teaching is to avoid becoming a redoubt for the mediocre. Responding to these manifest needs, decision-makers are loosing a blizzard of laws, regulations, and new standards. But they are doing so in a disjointed, piecemeal fashion. Policy changes in teacher education, for example, are coming about without reference to necessary corresponding adjustments in such other sectors as certification, compensation, and systems for evaluating and rewarding teachers. Notably lacking is any larger sense among framers of public policies that these are systemic matters; no single step or policy to improve the teaching profession can make long-range sense unless it is part of a larger design that integrates policies and actions in all areas affecting teacher education.

Most fully developed professions control the main functions that affect them and can usually speak with one reasonably authoritative voice. This is patently not so in teacher preparation, where owners of at least part of the action include, among others, the American Association of Colleges for Teacher Education, the National Education Association, the American Federation of Teachers, and a host of state agencies. Their long-range goals show potential for compatibility, even collaboration, but in their daily lives they often work at cross-purposes in a ceaseless battle to retain and expand their terrain. There is no discipline in their diversity.

The situation in five key domains of teaching as a career provides convincing evidence of the effects of this fragmentation.

- In *generating and codifying knowledge*, most of the nominally responsible colleges of education operate from a strait-jacket. Held in low esteem on most campuses, they have or ask for little of the autonomy that medical or law schools enjoy. Nearly all play it safe by sticking close to the university-based liberal arts model rather than branching out into more desirable but adventurous off-campus ties to schools, where teaching happens.
- The twin functions of *recruitment and selection*, which the university, the school system, and sometimes state agencies control, vary

markedly from those of the more established professions, where a commitment is a prerequisite to entry into training. Only 50–70 percent of those who complete certification programs in teaching ever make it to the classroom.

- The *transmission of knowledge*, a crucial function in teacher education, still lives, with justification, by the hoary maxims that "teachers teach as they were taught" and "teachers learn to teach by teaching." Without social context a neophyte teacher is at a singular disadvantage. The separation of the sites of formal (college) and informal (school) instruction and socialization is a dysfunctional element, even a major sore spot, in preparing new teachers. Beyond verbal or written exhortation, however, there are few signs of efforts to ease it on a serious, permanent basis.
- The *enforcement of the profession's norms* furnishes a clear case of the dysfunctional organization of teacher preparation. Administrators, the teachers' day-to-day supervisors, are not members of the profession. Nor do they go by the same book as teacher educators, whose concerns are developmental and mainly professional. To the administrator, the teacher is both classroom instructor and bureaucratic employee. Value systems for the two are often contradictory.
- The *motivation and career potential* of teachers present classic examples of the case for integrating changes in teacher education into a systemic whole along with standards for evaluating teachers and methods for locating and acknowledging outstanding performance. Whether through career ladders, monetary bonuses, premium training, or other means or combinations, new teachers must feel themselves to be part of a process that respects and fully rewards their efforts.

Out of the findings of recent research in these domains has emerged a dilemma for agencies, institutions, and decision-makers charged with staffing the nation's classrooms: Is collaboration among them sufficient, or should they go back to the drafting board and start fresh? There are challenges and perils in both. Collaboration customarily centers on governance while slighting content. To the main institutions concerned with teacher education—post-secondary institutions, school systems, and teachers' organizations—it is not a high-priority item, a status that would surely vitiate any serious attempt to establish it. Too, the understandable assumption of the potential participants that enlightened self-interest is an appropriate foundation upon which to build professional education may be mistaken. Moreover, there is reason to suspect that final blueprints for collaboration would have to include roles for chief state school officers, legislatures, and other increasingly active groups and agen-

cies. These factors may comprise a prescription for failure or, at best, ineffectual performance.

Starting from scratch and creating a Utopian site-based system for training teachers where they work carries echoes of world government or other panaceas that have fizzled out. But the highly successful model in medical education in which Johns Hopkins Medical School created new but lasting modes and standards nearly a century ago, shows that dramatic ventures to train a profession can succeed, at least in a relatively uncomplicated era. At the core of the Hopkins experience was respect for careful research, detailed planning, sufficient time, and adequate initial financial backing. Whether these would be available to create new systems for teacher education in the mid-1980's is unknown. The shortcomings of today's piecemeal attempt dictate that responsible leaders make the effort.

Reform and Equity: The Case of School Dropouts

One of four of the roughly four million students who enter the ninth grade every year do not graduate from high school—on time or ever. Although questions of definition, uneven availability of data, and statistical method may cloud the accuracy of this figure, most educational research scientists accept it, and some have even put it at 28 percent for the past five years. If graduation from secondary school is the good thing—for society, the economy, and American youth—that popular wisdom holds it to be, then there is cause for concern that so many of our youth do not make it.

Critics of the push for educational excellence of the mid-1980's contend that this concern is nearly absent from the rising tide of reports on reforming schooling. They assert that the elevation of academic standards, which is the centerpiece of the movement for reform, leads to insensitivity to issues of educational equity and thus impairs the schooling of low-achieving students, particularly those of low-income background. Spokespersons for reform through quality counter that increased demands on students through more rigorous course content and better use of time, among other means, will yield greater effort and higher levels of achievement and self-realization by all students.

Caught in this crossfire are the nation's potential dropouts, whose talents and view of education have little to do with academic excellence or achievement. The majority suffer from no learning disability nor do most pose insurmountable threats to disciplinary stability in the classroom. But society's expanding expectations for all students include successful completion of the high school grades, a goal that most low- or non-achievers have been unwilling or unable to meet

even in a decade in which the requirements and standards of American high schools have weakened perceptibly. What is to become of this youthful "population at risk" if excellence, rigor, and attendant virtues become contagious in our schools?

The dilemma of equity and/versus/or excellence probably arouses more passion than any other spinoff of the reform reports, and objectivity is not always present in the research literature on the family of problems it has spawned. Good data and analysis on dropouts nevertheless are becoming available, and it is to this material that decision-makers should consider turning for broad perspectives and an awareness of the pitfalls that recent experience provides.

Perspectives on Dropout Prevention

The reasons American youth leave high school early stem from three principal sources: their educational experiences, family problems, and economic factors. Although only one of these is a direct consequence of what happens to them in schoool, it is by far the most prevalent cause of early departure, and it is the only one that falls within the purview of pure educational reform. Simply put, whether they possess the requisite ability or not, many students cannot or will not do the work. Poor grades, truancy, in-school delinquency, suspension, expulsion—all are manifestations. While less marked statistically, the problems associated with teenage pregnancy and motherhood as well as of a student's family of origin, such as broken homes, often turn students away from school. The obligation many feel or must undertake to support this family or one of their own also can persuade students to drop out. For others, the attraction of a paying job in an expanding economy is greater than that of an almost predictably dismal career in high school.

It is evident that the philosophers of educational reform intend that such central themes as a more demanding curriculum, more rigorous use of time, and high achievement should apply to all students in all schools at all levels. The consequent messages of the major reports are clear (if not unanimous). All students should undertake a tougher core curriculum with fewer electives. Stricter policies on attendance and the use of school time should be matched by firm, explicit, and demanding requirements for homework. Grades must measure actual academic accomplishment and not motivation. Promotion should be a direct result of adequate performance. Students should take tests of achievement at major points of transition.

Variations and expansions of these recommendations appear throughout the documents on reform. In some particulars, they may have a salutary effect on possible dropouts, although the overall conclusion of studies on the potential positive impact of stiffening the curriculum is that enrollment in the academic track contributes little to student outcomes. It helps to raise the test scores of seniors, but

those with low grade point averages who complete core requirements show little discernible improvement. The data on the use of time by secondary students yield a consistently positive, but modest, correlation between achievement and the time students spend on homework. As a general rule, too, students respond well to teachers whose demands are greater, although many teachers at the secondary school level tend to have lower expectations and therefore set softer standards for certain groups of students, notably racial and ethnic minorities.

Despite these inconclusive exceptions, research on the prospects for low-achieving students of prospering academically in a reform regime points to frustration and failure manifested in increases in absenteeism, truancy, school-related behavior problems, and, ultimately, the dropout rate. The reform movement's prescriptions for a uniform set of core courses typically are at serious odds with well-documented findings that such "unidimensional" instructional structures, when applied to lower-achieving students, lead to a series of "lowers": evaluations by teachers and peers, self-evaluation and, inevitably, performance. Because core courses tap ability along a narrow, academic range, lesser students deprived of a broader variety of school experiences will be unable to display different kinds of talents and competencies. This does not elevate their self-confidence.

Lengthening the school day and assigning more homework, two of the key planks in the platform of excellence, confront marginal students with potentially weighty conflicts. How can they reconcile time needed for meeting heavier school commitments with what they require for jobs and families? Time for one is time taken from the other, and quality in both is destined to suffer. Add the pressures of doing enough creditable work in both domains and trying to carve out an ever-dwindling slice of time for beneficial extra-curricular activities—and the result may be a confused and disillusioned young person.

The impact on future dropouts of mandating higher academic achievement may be deadly. Already accustomed to failure, many such students usually have reacted with apathy, absenteeism, and negative activities, all of them precursors to dropping out, to standards of school performance they consider unattainable. Recent experience in subjecting analogous students to minimum competency testing is illustrative. Students at risk, most of them from minority racial/ethnic backgrounds, fail these tests in substantially higher numbers than do whites. Although no systematic evaluative studies of the direct psychological effects of such failure on lower-ability students are available, a prediction of close correlations with rates of dropping out doubtless would not be far-fetched.

Schools with large dropout populations unsurprisingly share cer-

tain characteristics. They are large. They have a high percentage of minority students from urban settings that feature severe unemployment, crime, poverty, and female-headed households. Administration is poor. There is only weak cooperation between teachers and administrators, and matters of control and discipline occupy a higher priority than do instructional objectives. Teachers apply sanctions and rules inconsistently. Conventional social norms receive little attention.

Of these characteristics, size is one that researchers and practitioners assert may affect the others and the larger question of providing better educational services to students of lower ability. In smaller schools, according to most available research, the conditions obtaining in the larger ones are nearly reversed. There is more order and stronger satisfaction with school life. Students achieve better. More of them participate in extra-curricular activities. Smaller schools are more manageable. Smaller classes and greater flexibility in scheduling are the rule rather than the exception. Low student-adult ratios prevail, and they are beneficial to everyone.

Closely linked to size as a modifiable characteristic of the school are the structure and content of the curriculum. Evaluations of dropout and delinquency programs attest to the usefulness of learning approaches tailored, to the extent possible, to individual aptitudes and interests. Self-designed and self-paced curricula integrating vocational and academic subjects with work experience show promise because they enable the disaffected student to perceive the relevance of schooling to the workplace.

The climate of the school can be manipulated to deflect students at risk into more productive learning habits and values. Clear rules and consistent enforcement help to create a productive environment, while a system of sensible and equitable academic rewards, necessarily different from those that have alienated these students in the past, can help to motivate them. Less easily attainable but an important contextual force is the development of an atmosphere in which students, teachers, and administrators come to value rather than deprecate achievement and intellectualism.

Strategies and Examples

Changing various organizational, instructional, and attitudinal qualities of schools thus can help to deter students from leaving early. But such revisions normally carry the process of deflection or reorientation only part of the way. Research on reducing dropout rates demonstrates that policy-makers must be prepared to consider alternative arrangements that depart radically from traditional forms. The high school diploma may confer only a limited advantage in life and the job market—indeed, leaving school before graduation actually

reduces delinquent behavior—but the personal and societal benefits may be significant. If graduating means gaining knowledge and acquiring self-worth, rather than merely building an adequate attendance record for 12 years, then programs to keep youth in school are worth the cost and effort.

A review of 17 dropout prevention programs indicates several common characteristics. They use a variety of integrated strategies rather than a single approach. They transfer potential dropouts from their regular schools to different kinds of environments. Most are small, with administrators concentrating resources narrowly on small populations. Programs that recorded some success offered a different experience in learning from that which students had been receiving. In some instances, they combined potential dropouts with those who had actually left school. Sharing a strong vocational emphasis, these programs imparted practical, often job-related, skills in school and encouraged students to apply academic learning to real life situations. As part of the vocational emphasis, they stressed learning outside of the classroom, often in connection with paid employment. Confirming research findings, these alternative programs were small, had low student-teacher ratios, and highlighted individualized instruction. They also included strong counseling components.

A prototypical example of an alternative educational program that combined most of these features was Project PATHE, which operated in seven secondary schools in Charleston, South Carolina, between 1980 and 1983. Designed to permit a comparison of the relative efficacy of organizational change and individual treatment, Project PATHE attempted to create a system for shared decision-making among community agencies, students, teachers, administrators, and parents in managing the schools while carrying out an intensive program of academic and counseling services for students at risk. Contrary to widespread perceptions about such enterprises, the component of governance worked, but the direct service phase had only uneven success—marginally effective for younger students (who did receive stronger services) and ineffective for older, high school age participants. There is other evidence, however, that the individualized service approach has potential at the secondary school level.

The West German educational system treats the matter of dropout prevention by appearing to avoid it altogether. Through an early and relatively simple process of differentiation, which continues throughout every West German child's education, children are labeled and ticketed as early as the fifth grade and no later than the seventh, for either the fast academic track, which leads the most talented quarter to college and a professional career, or technical secondary school, where another quarter prepare through grade 10 for commercial and technical occupations. Most of the remaining half who are judged

unqualified for more demanding secondary school finish formal schooling with grade 9. There is little mobility, except downward, within this tracking system, although second chances for late developers are technically possible, and flexible variations are creeping in.

Although its principal assumptions conflict with the democratic values of the United States, where second, third, and fourth chances are available, the West German experience may provide some useful elements of a model for future programs here. Schooling does not stop at 15 or 16, it is actually compulsory through age 18. An array of full-time vocational schooling and, most notably, a dual system of part-time vocational schooling combined with apprenticeship fill the two-year gap. Half of the 16–18 year-olds in West Germany participate in this process, which offers preparation in 450 fields leading to over 20,000 specialized occupations. Employers, educational authorities, and unions cooperate in planning the apprenticeship. By the age of 18, young Germans thus are ready for certification as skilled workers with no loss in requisite academic subjects. They gain experience in the workplace and receive such benefits as stipends during the apprenticeship, union wage scales on employment, and paid vacations. More than half of the successful apprentices get jobs with the firms that trained them and, although the employment picture in West Germany is less promising than it was a decade ago, the rest have few difficulties finding something in their specialties. At the age of 20 at the latest (following a 15-month period of military or alternative service all males undertake between apprenticeship and career entry), young Germans usually know exactly where they are going in life. There are few dropouts from a system that offers tangible rewards of this order.

From an American standpoint, these arrangements are riddled with major flaws. Above all others, they reinforce economic and social gaps by intentional segregation and all but permanent tracking. Despite the class-related separation of more and less academically able youth, however, West Germany's largely successful post-World War II educational history gives researchers cause for reflection about once-unthinkable possibilities. If our weakest students can be taught to pass minimum competency tests and more demanding courses, how can these measures possibly improve the education of the strongest? But if they fail, can we tolerate an increased dropout rate that may affect different classes and races unequally? Put in different terms, such issues force American educational policymakers to confront the rationalization of inequalities, in whatever guise they appear, in a democratic society. Perhaps they tolerate them already. In the rather different area of teaching advanced reasoning in the schools (see "Higher Order Skills in the Three R's," below), for example, educators appear ready to concede that the distinction between good and poor students will widen but that those of lower

ability will still learn more and learn it better. To add to an unclear picture, some research indicates that the costs of instructional grouping to the lowest students' achievements and feelings about themselves are not justified by the uncertain benefits of the practice.

The issue of grouping or tracking, which is as thorny and politically loaded as any that educational researchers face, is at the ideological heart of any program designed to lower the dropout rate. Invidious though it appears, differential treatment of potential dropouts is justified if it meets these criteria: (1) The basis for differentiation must be accurate a. .ppropriate; (2) the strength of the differentiation must be no greater than required for effectiveness; (3) parents and students must understand the process of differentiation; and (4) the probable consequences of assignment to the lowest group must be favorable and acceptable to those students and their parents.

At the center of post-secondary education in West Germany is vocational education, an honorable path which holds the prospect of early employment, further training, and a solid career for students who lack a strong academic bent. In the United States, vocational education is both a relatively painless route to a high school diploma and a time-killer that functions with fair success as a huge dropout prevention program. Data showing that more future dropouts are enrolled in general education curricula may help spur improved and better focused vocational education programs. Effective efforts to lower the rate of dropouts also demonstrate the usefulness of "experiential" out-of-school learning programs, which do no harm to and may promote the acquisition of academic skills.

Egalitarianism, Schooling, and Testing

The state of present knowledge on bringing educational reform about suggests uncertainty over how to raise standards for uniformly rather than selectively good effect. There is no philosophical consensus on how to avoid creating an ever-widening chasm between educational haves and have-nots. Contrary to conventional wisdom that narrowing social and educational gaps is a permanent national obligation, there is well-documented cause for apprehension over the possibility that the drive for educational excellence will recreate the separations that characterized American education a generation ago.

One overall effect of a reform movement that places a premium on such criteria as minimal competency tests for graduation, reduced electives, and increased academic requirements may be a striking expansion of the power of schools to make sorting judgments about students. Applying these and similar criteria, according to some research, can lead to more hierarchical and bureaucratic structures from state agencies to local schools and *vice versa*. Tightly controlled

systems will make more explicit judgments about all students, but the least likely beneficiaries will be the economically poorer students, of whom significant percentages will be Black and Hispanic.

The quest for excellence comes at a time when schools have been demanding less of all students. Whatever the causes—the need for more pliant future workers, the egalitarianism of the social legislation of the 1960's, pressures to develop well-rounded citizens rather than academically trained drones, or others—there is evidence that the reduction of requirements has affected the majority of students, not just future dropouts. Most students are only marginally involved in academic learning. They spend few hours in school relative to time spent working and/or socializing, and they tend to avoid difficult classwork. But committed as they are to being popular, egalitarian, and universal, the schools would be judged harshly if they labeled all students as potential early school-leavers. Any hint of such large-scale failure by their children could create major problems of credibility and governance in the nation's 15,500 school districts.

The dimensions and character of the potential payoff for prospective dropouts from an across-the-board heightening of standards remain unclear and a subject meriting close investigation. What happens to those who stick it out? How do dropouts compare to high school graduates who receive no further education? Are there any greater rewards than for exiting early and into remunerative jobs? The forms that curricular or other changes take will require careful evaluation and monitoring, neither of which is yet firmly imbedded in the various prescriptions for gaining excellence. To gain closer insight into what happens to students as schools improve, administrators should consider assessing through a "full enrollment model," that is, by including scores for students who have already dropped out. The latter could be estimated from earlier test scores and background characteristics. The likely outcome of such a model would be the reduction of aggregate scores which, however, would become more responsive to concerns of both excellence and quality. It would then be possible to assess the true effects of reform on students at risk.

Higher-Order Skills in the Three R's

Few of the disparities that exist between research and practice in education are as pronounced as the gap that all but isolates productive research on higher-order thinking skills from the daily realities of the American classroom. At a time when knowledge is expanding with breathtaking speed while acquiring once-unimaginable complexity, policies and actions calculated to improve the learning and teaching of advanced thought processes remain near the bottom of

the in-boxes of most of education's decision-makers. Moreover, with limited exceptions (Goodlad, Boyer, and ECS-Cary), the principal reform reports of 1982–84 fail to highlight this looming issue. Yet the manner in which it develops may ultimately determine how—or even whether—today's students are to function effectively in their future jobs and social roles.

Since the mid-1950's, the field of cognitive science—a still-evolving interdisciplinary blend of human information processing, linguistics, and "artificial intelligence" (the study of computers designed to exhibit human-like intelligence)—has permitted scholars to explore the higher-order skills involved in reading, writing and arithmetic in addition to the more mechanical procedures that were already familiar. Research in reading is no longer limited to analyzing perception and oral reading; it now extends to the thought processes of understanding. Similarly, scholarship in writing has moved decisively beyond inquiry into grammar and handwriting into more contemporary questions concerning the composition of thoughts. Research workers examining the teaching and learning of mathematics and the sciences have made important strides in their examination of the framing and solving of problems that lie beyond the technical mathematical calculations their predecessors had long observed and analyzed.

Central and common to research in higher-order thinking skills in all three fields is broad acceptance of profound change in traditional views of people as learners. Until only 30 or so years ago, the sum of a person's competence was held to consist of action plus behavior. But now, surely more than ever in our history, information and thought processes may guide and dominate learning and action. Like it or not, people must now construct their own knowledge. It is timely and appropriate to ask whether organized education can yet provide the direct instruction that will enable people to do precisely that. Providentially, current research in all three realms—reading, writing, and mathematics/science—is producing useful answers.

Reading and Thinking

In reading, students are learning that decoding print, i.e., translating written words into speech, is only an early phase of a larger activity that is both interactive and constructive. Although much of what is taught as reading in the later primary grades may actually be critical thinking and studying, most school systems still value remembered facts and fallacies acquired through outdated and outmoded instructional methods. Instead of finding ways to integrate or combine content with the thinking processes required to gain genuine mastery, most current practice treats the two as distinct and indepen-

dent entities. One scholar's observation of reading and instruction periods in a sample of classrooms revealed that the teaching of comprehension had accounted for exactly 28 out of 4,469 minutes. Analysts of commercial reading instruction materials found that teachers' guides and student materials concentrated on the development of phonics and word recognition to the nearly total exclusion of higher order skills in understanding meaning. It is unsurprising that test scores in comprehension have declined alarmingly while proficiency in lower-level or mechanical skills have improved or remained stable.

Given the reluctance of most schools—and the opposition of some parents—to infuse higher-range skills of comprehension into reading instruction, it is understandable that most students, particularly those from families that do not foster intellectual development, rarely possess such abilities by the time they enter high school. Research points emphatically to a need for revised reading curricula and instruction that will encourage learners to acquire these abilities. Like those that are appropriate for writing and mathematics/science, successful techniques for nurturing the development of advanced comprehension in reading fall within the broad scope of problem-solving. Skilled problem-solvers plan their approach to the problem at hand. They monitor their learning as they read. They apply strategies to foster learning. They evaluate what they absorb. When appropriate, they correct and revise their approach.

For reading, as for the other basic skills, there is no apparent need to devise courses or curricular materials in reasoning or comprehension as such. In "regular" elementary-level reading classes (there is little formal reading instruction after the sixth or seventh grade in most systems), young readers can learn to reorganize poorly written texts, infer the meaning of difficult vocabulary from text, and spontaneously bring to bear whatever background knowledge they possess to help them to perform these tasks independently. According to considerable literature as well as intensive applied research, however, there are right and wrong ways to achieve these admirable goals. The wrong way is to separate higher order-oriented instruction from the actual context of the reading class by offering separate, finite dosages of school system-dictated, teacher-led work in the composite skills. Although brief success occasionally results, there is little proof that students continue to use their newly, perhaps temporarily, obtained skills in other settings. Teachers have long claimed that students are reluctant to transfer their knowledge.

The introduction of advanced techniques and strategies, as students need them to understand texts, offers far more positive prospects for their attainment of helpful abilities to reason. Long-lasting and significant improvements have occurred in situations where students exercise a high degree of personal responsibility for devel-

using these qualities. To make this happen, the teacher must be disposed to establish a supportive ambiance in which supervision gradually gives way to sharing control and, in time, to assumption by students of all, or nearly all, responsibility for learning.

This does not happen overnight. It calls for a lucid design and careful structuring. In one example, called "reciprocal teaching," a teacher and group of students alternate in conducting a dialogue on a specific section of text. The adult teacher assigns a segment of the passage to be read and either indicates that it is his or her turn to be the teacher or assigns a student to teach it. After all have read the segment silently, the teacher (student or adult) for that unit summarizes the content, asks a question that a teacher or test might reasonably ask, discusses and clarifies any difficulties, and finally makes a prediction about future content. All of these activities are embedded in as natural a dialogue as possible, with the teacher and the students giving feedback to each other.

Certain underlying principles guide this process of "reciprocal teaching." The teacher must first demonstrate the desired activities in comprehension, which should occur only in settings that are familiar as learning environments to the students. It is vital that students become sensitive to the need for these cognitive strategies of learning and that comments by teachers be consonant with actual levels of student competence. Fundamental, too, to "reciprocal teaching" is the overriding assumption that students will assume full responsibility once they have taken charge of their own learning. As the procedure unfolds, they perform at an increasingly mature level. Sometimes, their progress is fast, sometimes slow, but irrespective of the rate, the teacher offers an opportunity for students to respond, bit by bit, at a slightly more challenging level. As they master one level, the teacher's demands expand and students gradually accept for themselves what had been the adult role, fully and independently. In an ideal scenario the teacher fades into the background and becomes a sympathetic coach to students who are now qualified and enfranchised to take charge of their own learning from texts.

Neither "reciprocal teaching" nor variations of it can register overnight miracles. Yet recent applications of this method of transferring and obtaining superior reasoning skills in reading have led to major improvement in the comprehension scores of previously immature readers at the junior high school level after only three to six weeks. Moreover, teachers were effective, enthusiastic, and disposed to apply the method to other disciplines. Substantial evidence indicates that the techniques of "reciprocal teaching" have succeeded across a broad range of ages and educational levels, including, among others, learning disabled college students, gifted third graders, normal high schoolers, students of physics, and pupils in early mathematics.

The potential effects of this research and testing may thus extend beyond higher order thinking skills in reading and into curriculum reform writ large—to changes in teaching practices, textbooks and other instructional materials, the assessment of students, school organization and social climate and, not least, public perception.

Critical Thinking in Written Communication

Writing has received less attention than reading or mathematics and science as a subject for research. Until the past decade, the main efforts in the field centered on indicators of good writing and the developmental trends that were influencing it. Only recently has a substantial and credible body of data appeared on how the process of writing materializes. From this research it is evident that writing is the result of an intricate set of cognitive and linguistic skills that allow the formulation, drafting, and revising of a piece of coherent text. With the growth of knowledge of how writers compose, revise, and edit that work, it has become feasible and appropriate to analyze the teaching of these procedures.

As in reading, the main focus of contemporary research in writing is on developing and anticipating ideas and on the processes of planning and revision that make this possible. National assessments and academic research confirm that these higher-order matters (rather than shortcomings in grammar, spelling, and sentence structure) are the most prevalent and worrisome issues in writing. How children become proficient writers tells much about their capacity to absorb and employ critical thinking skills. Intimately tied to their acquisition of higher-order thought processes are the performance and sensitivity of their teachers. They must define and communicate methods for students to move beyond mechanically correct but essentially lower-order writing to a level of written communication that embraces analytical methodology.

In both structure and process, newer methods for orienting students to advanced reasoning in writing follow patterns, such as those of "reciprocal teaching," that work in reading as well. The central objective is to gain higher-order competence along a spectrum ranging from conversation to "knowledge telling" to "knowledge transforming." In order to become a capable or expert writer, the child who comes to school proficient in oral language must adjust to the difficult chores of learning how to sustain discourse without the numerous varieties of support a conversational partner provides. Yet children possess natural endowments, and the ability of an effective instructional system to aid them to capitalize on their gifts can help create a proficient writer.

The continuum from "knowledge telling" to "knowledge transforming" is the main phase in reaching for expertness. Although

often difficult, "knowledge telling" customarily is a rather uncomplicated "think-say" exercise that can be rapid and become nearly automatic. Making maximum use of cues generated externally and from the production of language itself, it requires little more planning, revision, or goal-setting than does ordinary conversation. Serviceable though it may be, however, "knowledge telling" does not usually respond to our culture's highest needs. Nevertheless, it continues to be a basic means of written expression through a person's post-secondary education and usually into a subsequent career.

The reworking and transforming of knowledge into expert writing demands a distinctly more complicated approach. Current research identifies several mental activities that mature writers perform. They employ such self-regulatory tactics as generating content while simultaneously detecting problems ("alternating"), checking the adequacy of courses of action, and merging the results of these efforts. At the same time, their search for relevant knowledge demands that they "elaborate constraints," that is, that they undertake a sophisticated process of gaining access to difficult material that helps them to produce a holistic analysis of a problem. Mature writers construct mental designs of text that combine near photographic, verbatim, and paraphrased representations with those of main point and purpose. They produce "integrated networks" which generate goals and coordinate representations at all levels of sophistication.

Writing that embraces higher-level skills, or combines them with those of less mature writing, can be a difficult, many-sided endeavor. Experts automatically check their work against their goals and view deficiencies as problems requiring solutions, often as major substantive revisions of text. They set goals, plan, and consider heavy-duty problem-solving to be a routine part of their work. They construct and elaborate intricate plots. Those who produce thoughtful and analytical prose worry about readability. No more than scattered indications of these concerns are visible in immature or lower-order writing.

Instruction in writing has begun to help children to do for themselves what the highly supportive school writing environment has traditionally done for them. Among the fruits of recent educational research are methods to assist students to learn, adopt, and gain personal control over the ways of experts. In one such process, called "procedural facilitation," students undertake a simple three-step sequence in which they first identify one self-regulatory function, such as planning or revision, that characterizes mature performance. Next, they describe it as explicitly as possible in terms of mental operations or functions. Finally, the teacher designs routines or supporting devices for simplifying this function. A tactic for revision, for example, could be reduced to a finite choice, e.g., "I'm getting away from the main point" or "people will not understand what I mean

here." The purpose of simplifying in this fashion is to allow children to start performing the self-regulatory function with as little additional burden as possible on their capacities for mental processing.

The results of such methods as "procedural facilitation" have been gratifying. Sixth-grade students showed admirable progress in gaining higher-level competency after only 12 to 30 classroom sessions of 45 minutes each in changing texts, planning for longer periods, making revisions of a higher order, internalizing and transferring new procedures, developing independent (rather than teacher-dependent) abilities, and changing strategies.

Reasoning in a Technological World

In mathematics and science, even more perhaps than in other domains, the veritable "knowledge explosion" of the past generation is creating and transporting with it material that is increasingly complex, abstract, and symbolic. Moreover, this knowledge is expanding so rapidly that many persons risk professional obsolescence unless they keep learning and updating themselves. Even the most talented learner can neither acquire nor store the sheer amount of mathematical and scientific knowledge that threatens to engulf society. More than ever, higher-order reasoning skills are an imperative for all who traffic in complex information and concepts in these fields. In some specialized areas such as electrical engineering, the traditional teaching of predominantly factual information is giving way to providing general principles and methods. But throughout the educational system many teachers and most students have primitive conceptions about how people apply their mental facilities, especially in these fields. Regrettably, too many retain too little of the knowledge they have supposedly learned and which they must possess to ascend to higher levels of performance.

According to recent cognitive science studies, much underlying knowledge that accounts for good performance is often "tacit" or outside the range of an individual's conscious awareness. Native speakers of a language, for example, are usually unable to spell out rules of correct grammar and formation of sentences. The rules are simply tacit—implicitly understood to the speaker but largely immune to explanation or quantification by those who, usually unconsciously, observe them most religiously.

In contrast to these findings about knowledge are numerous recent studies demonstrating that students often exhibit gross misconceptions about basic scientific concepts and principles that should long since have become reliable tools of their intellectual repertoire. Moreover, preexisting conceptions and faulty information may impede their acquisition of higher-order thought processes. Adding to the difficulty of conveying instruction in sophisticated thinking pro-

cesses is the quality of implicitness of today's mainstream teaching, which mostly relies on presenting information, furnishing examples, and creating opportunities for practice. Such instruction customarily does not develop underlying thinking skills, which have many sides and dimensions, and depend on subtle interactions among many essential components.

The key proficiencies in thinking and reasoning that science and mathematics demand fall into four main categories: solving problems, organizing knowledge, interpreting concepts, and improving conceptions about thinking and learning. All four apply as well to reading and writing. Of the four, problem-solving occupies a central place as the indispensable skill for those engaged in or applying the benefits and lessons of technology to the needs of the modern world.

The fundamental difficulty any complex problem poses is the need to make decisions judiciously. Inexperienced students tend to make haphazard, intuitive, or speculative judgments when selecting possible paths toward a solution. Research provides several ways to enhance the student's chances of finding logical solutions. It is useful, for openers, to decompose a potential solution into successive steps of manageable size. Most solutions consist of detailed sequential steps of an argument that lead from known information to a desired goal, and immature students often bog down in the details of these steps. A much more efficient technique is to outline a solution, fill in details, and continue by successive approximations until all stages have received detailed specification.

This method of "progressive refinement" has manifold applications. In computer science, for example, the student may write a program by first making a rough flow chart and then gradually elaborating it into progressively more detailed instructions. A problem in mathematics or physics lends itself most readily to a clear solution when the student sketches the outcome in qualitative or pictorial language, gradually refines it, and ultimately generates a precise solution. Valuable hints to prevent students from getting irremediably stuck may also come from heuristics, which are explicit general rules providing advice about how to find a solution. Easily taught and applied, a venture into heuristics can take the form of a simplified version of a problem which may trigger useful discernments about how to tackle a larger real problem.

Learning how to search for solutions is only part of a student's initiation into solving problems in mathematics and the sciences. The student who cannot systematically characterize and describe a problem, if necessary through symbols and pictorial representations, risks acquiring a serious miscomprehension of it and of making potentially costly errors in reaching a correct solution. At the other end of the process, the untrained problem-solver often fails to apply such

obvious checking criteria as completeness, clarity, consistency, and simplicity to a supposedly achieved solution. Lamentably, current teaching practices perpetuate older value systems by centering on the product rather than the process. An emphasis on formalism and precision still pervades, to the detriment of broader, even intentionally vaguer and more conceptual approaches.

Paralleling and crucial to problem-solving in mathematics and science, as in all academic fields, is the ability to organize knowledge, a matter that teachers too frequently slight in their preoccupation with sating students with content that may become archaic before graduation. Countless students are also conspicuously deficient in interpreting concepts. In scientific and mathematical subjects, in particular, successful learners require clear, unambiguous definitions of larger ideas, but they must understand that such concepts also embrace ancillary knowlege—procedures for interpretation, close familiarity with standard properties, knowledge of important special cases, and sharp sensitivity to the conditions in which to apply the concepts—in order to make them flexibly usable.

Too often, the failure or reluctance of students to consider thought processes for using and extending their knowledge inhibits their performance. Clinging to long-held but usually mistaken notions about human thinking and learning, their criteria for "understanding" may be narrow, even inflexible. For example, students often regard mistakes as sources of embarrassment or as accidental happenings requiring rapid rectification and dismissal. Yet such mistakes merit study in their own right and may turn into valuable sources of enlightenment. Cognitive science reinforces this once-unthinkable theory by demonstrating that mistakes are not freak occurrences. They happen almost predictably whenever humans carry out difficult tasks, and it is helpful to devise methods for preventing, detecting, diagnosing, and correcting them. Just as diseases provide valuable data and insights about normal physiological functioning, mistakes offer solid information about how the mind works.

Choices for the Schools

Equipping students with the skills and methods required for higher-order reasoning in today's schools, even in many universities, confronts legislatures, school boards, teachers' organizations, parent groups, administrators, and teachers with a constellation of new, largely unanticipated choices. Should these skills be taught separately, as is happening in some school systems, in classes or courses devoted solely to learning about "thinking?" Or are they better left in the regular, if conservative, flow of instruction in subject matter classes? How, or should, textbooks be changed to reflect the enhanced need for transmitting critical skills? What are the implications

for assessing the performance and possible adult futures of today's pupils? Are teacher training institutions prepared to make the burdensome adjustments that may be required to install training for teaching higher order methods in their programs? Will a stronger focus on bringing these skills into the classroom harm or ultimately benefit less accomplished learners?

Recent on-site experience prompted by the findings of educational research yields impressive data on one controlling aspect of higher order reasoning—teaching it in the classrooms. Such methods as "reciprocal teaching" (reading), "procedural facilitation" (writing), and "progressive refinement" (mathematics-science), among others, spotlight areas of potential success to exploit as well as pitfalls to shun. When merged with the perceptions gained from analogous work in mathematics and science, a consistent pattern of desirable criteria emerges. These include: (1) a careful and consistent educational design that prizes well-planned and well-informed instruction; (2) emphasis on inculcating higher-order skills in substantive courses and not in settings devoted solely to technique; (3) drastically revising testing methods geared to evaluating intellectual skills (especially in mathematics, where computational achievements are valued more highly, by far, than the skills of analysis and comprehension); (4) greater curricular selectivity so that students may give more time to developing critical reasoning capabilities; (5) a reorientation in the preparation of teachers and in their perceptions once in the classroom; (6) changes in the purpose and content of textbooks and greater flexibility in selecting and purchasing them; and (7) expanded, more intelligent exploitation of the new information technologies now available, provided that there is an improvement in the quality of software.

Educational research may eventually offer authoritative answers to other policy-level questions regarding higher-order reasoning skills. The material now available permits some tentative judgments, even though higher-order reasoning remains *terra incognita* in much of American education, and decision-makers appear reluctant to alter their maps in this vital area. Teaching and learning thinking techniques may call for sea changes in how teachers allocate—or are permitted to allocate—time, traditionally a passion-arousing issue. Yet teaching higher-order thinking skills cannot become a fad that could backfire or an onerous "add-on" destined to bedevil teachers and students alike. It is becoming a high-priority imperative throughout education, and historic administrative rigidities should not inhibit its development. If higher-order reasoning skills are to enter the curriculum, strongly held opinions on the use of time must shift dramatically. Equally important would be an attitudinal change throughout school systems on the need for greater explicitness and imagination in instruction, and, perhaps less readily acceptable, a

broad willingness to take sensible chances, even a readiness to turn mistakes to the learner's advantage. Acquiring advanced thinking skills seems to call for students to work more frequently and closely in small groups, in which less-prepared or less capable students may receive credit for work they may not have done. In today's schools, this intimacy could be deemed to foster activities by students that, by present ethical standards, schools have usually judged to be cheating. Is it cheating when everyone learns more and learns it better?

The matter of testing, with its accompanying concern over issues of equity, is still a no man's land in the world of higher-level reasoning as it is in teaching. Almost by traditional definition, tests of knowledge, aptitude, and competency highlight factual information. They have two principal functions: to provide accountability of and for all participants in the educational process, and to motivate students to study. Adaptation to an educational order in which thinking critically is valued as highly as mastery of factual material would be difficult. It would probably be unwise to test the level of a student's command of an explicit process and inadvisable to abandon the generally healthy knowledge-centered assessments that are finally in place in the large majority of states. There are no ready answers to the questions of how or whether to evaluate thinking skills. Nor can research yet provide reliable data on their effects on poor students. Fragmentary evidence hints that good-poor chasms would widen but that the work of those nearer the bottom would show improvement.

These issues will inevitably provoke controversy as schools and states begin treating the "basics" as something less than ends unto themselves. As they turn, whether incrementally or in one great surge, to viewing higher-order skills as the "basics" of the real world, they may encounter challenges unlike any they have known. With time and thoughtful spadework, most are comfortably surmountable.