The 1987 Presidential Address

Learning In School and Out

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It takes all sorts of in and outdoor schooling
To get adapted to my kind of fooling.
—Robert Frost

Popular wisdom holds that common sense outweighs
school learning for getting along in the world—that
there exists a practical intelligence, different from
school intelligence, that matters more in real life. As is often
the case, this wisdom is difficult to assess directly from a
base of scholarly research. But recent research on the nature
of everyday, practical, real-world intelligence and learning is
beginning to provide a basis for understanding what distinguishes practical from formal intelligence. Drawing on
this work, I want to explore in this essay four broad con-
trasts which suggest that school is a special place and time
for people—discontinuous in some important ways with dai-
ily life and work. Then, in light of these contrasts, I will con-
sider where and how the economic, civic, and cultural aims
of education can best be pursued and whether schooling
itself should be reorganized to take account of what we are
learning about the nature of competence in various aspects
of our lives.

How School Learning Differs from Other Learning

A small body of recent research by cognitive anthropolo-
gists, sociologists, and psychologists has examined cognitive
performances in a number of practical settings. Cumulative-
ly, this research highlights four broad characteristics of men-
tal activity outside school that stand in contrast to typical
school work. The studies I discuss here have examined very
specific work situations, but the findings suggest wider
applicability.

Individual cognition in school versus shared cognition
outside. The dominant form of school learning and perform-
ance is individual. Although group activities of various kinds occur in school, students ultimately are judged on
what they can do by themselves. Furthermore, a major part
of the core activity of schooling is designed as individual
work—homework, in-class exercises, and the like. For the
most part, a student succeeds or fails at a task independently
of what other students do (except for the effects of grading
on a curve). In contrast, much activity outside school is
socially shared. Work, personal life, and recreation take
place within social systems, and each person’s ability to
function successfully depends on what others do and how
several individuals’ mental and physical performances
mesh.

An elegant example of this social distribution of know-
ledge and skill has been provided by Edwin Hutchins (per-
sonal communication, April 1987), an anthropologist who
has studied navigation practice in the highly technological
work environment of U.S. Navy ships. The activity of in-
terest occurs on a ship being piloted into and out of San
Diego harbor and involves six people with three different
job descriptions. On the deck two people take visual sight-
ings on predetermined landmarks, using special telescopic
devices mounted on gyrocompasses that yield exact read-
ings of direction. They call out their readings to two other
individuals, who relay them by telephone to a specialist on
the bridge. This individual records the bearings in a book
and repeats them aloud for confirmation. Next to the re-
corder, another individual uses specialized tools to plot the
ship’s position on a navigational chart and to project where
the ship will be at the next fix and beyond. These projec-
tions of position are used to decide what landmarks should
be sighted next by those on deck and when a course correc-
tion will be required. The entire cycle is repeated every
one to three minutes.

No individual in the system can pilot the ship alone. The
knowledge necessary for successful piloting is distributed
throughout the whole system. Furthermore, important
aspects of that knowledge are built into tools. These aspects
of knowledge, although not needed by the people who ac-
tually pilot the ship, are needed by cartographers and gyro-
compass builders. Thus, there is a further sharing of knowl-
edge—with tools, and with the builders of tools, who are
not present during piloting, but who are part of the total
knowledge system required for successful piloting.

Pure mentation in school versus tool manipulation out-
side. The centrality of tools in ship piloting suggests a sec-
ond major contrast between cognition in school and out-
side. In school, the greatest premium is placed upon “pure
thought” activities—what individuals can do without the
external support of books and notes, calculators, or other
complex instruments. Although use of these tools may
sometimes be permitted during school learning, they are
almost always absent during testing and examination. At
least implicitly then, school is an institution that values
thought that proceeds independently, without aid of physi-
cal and cognitive tools. In contrast, most mental activities
outside school are engaged intimately with tools, and the
resultant cognitive activity is shaped by and dependent
upon the kinds of tools available.

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The ways in which tools shape, enable, and share cognition are especially clear in the history of navigation. Sailors once navigated by the stars; in addition to recognizing the constellations, they needed to perform complex geometric calculations. Simple magnetic compasses dramatically changed the skill requirements for navigation, although computations to compensate for degrees of variation between magnetic and true north were still needed (Dunlap & Stufeldt, 1969). Later, the invention of a compass with built-in compensations for variation provided a tool that pointed directly to true north, thereby eliminating most of the computational work. But it was still necessary to know the relationships between north and other points of the compass to determine direction of sighting. Today’s gyrocompasses remove even that requirement, because they compute and name the direction of sighting. With each of these changes in technology, compasses in effect became “smarter,” and the user needed successively less skill. But the total system lost no intelligence or knowledge. Instead, some skill and knowledge passed out of the hands of compass users and into the hands of compass designers and their products.

Cognitive tools can be as simple as lists of frequently used calculation results. In the days before computers, when we did statistics by hand, we frequently referred to books of tables containing such esoterica as square and cube roots, arcsine and other transformations. We did not need to know how to compute these, only how to read the tables and use the information in the context of some larger task. In 17th and 18th century England and America, Patricia Cline Cohen (1983) tells us, many people of very limited formal education used Ready Reckoners, books containing tables of common price and measurement calculations. Such tables were in demand because of the need to use, and sometimes convert between, various systems of money, weights, and measures. Similar but more task-specific tables are used today by Brazil’s black market lottery bookies, many of whom have had little or no schooling. Schliemann and Aciony (in press) describe in detail how these bookies manage to operate a very complex lottery system, taking many different combinations of bets with varying payoffs, without needing to calculate—or even know about—permutations, probabilities, or ratios. Instead they use memorized or written tables specifying the number of possible combinations for a given string of digits. Like Ready Reckoner users, the Brazilian bookies are able to function in a much more demanding mathematical system than they could if they had to set up and carry out calculations on their own. They share their mental work with cognitive tools that others have prepared.

Tool use is not only a way for people of limited education to participate in cognitively complex activity systems; it is also a way of enhancing the capacity of highly educated people well beyond what they could do independently. The manager who uses simulation tools to develop business forecasts and strategies, for example, shares an intellectual task with a computer and its software. This sharing shapes what the manager needs to know: less today than 30 years ago about performing computations, but more about how to interpret complex, multivariate statistics and graphs, and, probably, more about complex economic theory. (See Simon, 1977, for a discussion of how the growth of these management tools is changing cognitive demands in the business workplace.)

Symbol manipulation in school versus contextualized reasoning outside school. Extensive use of tools is only one of the ways that out-of-school thinking engages the physical world more than in-school thinking. Outside school, actions are intimately connected with objects and events; people often use the objects and events directly in their reasoning, without necessarily using symbols to represent them. School learning, by contrast, is mostly symbol-based; indeed, connections to the events and objects symbolized are often lost.

Sylvia Scribner (1984) has studied the use of mathematics knowledge by dairy workers who assemble and price orders and take inventory in the warehouse. She documented multiple ways in which these workers used knowledge of case size and physical space to make their work physically and temporally more efficient. Here is a preorder, an individual whose job is assembling milk product orders, describes how he filled an order for half a case:

I walked over and I visualized. I knew the case [of size 16]. I was looking at had ten out of it, and I only wanted eight, so I just added two to it . . . I don’t ever count when I’m making the order. I do it visual, a visual thing, you know. (p. 26)

In another example, men taking inventory in the dairy warehouse used the physical environment as part of their arithmetic calculations. Because they knew exactly how many cases filled a certain space, they subtracted from that number the number of cases they estimated were missing from the cube the cases would form if the space were completely filled. Scribner’s dairy workers, then, did less work that is recognizably arithmetic than we might have expected. But they got reliable arithmetic results by treating the material they were working with as part of their calculation process, rather than by just operating on symbols.

Another example of how physical objects or materials can render arithmetic performance unrecognizable from a school perspective has come from Olivia de la Rocha’s (cited in Lave, Murtagh, & de la Rocha, 1984) study of people in a Weight Watchers program. Weight Watchers are a particularly good group in which to study arithmetic applied in everyday life, because they must calculate recipes and exact portions of food every day. In one particularly interesting case, a person was observed solving the problem of measuring out three-fourths of two-thirds of a cup of cottage cheese. Instead of multiplying the fractions, he used a measuring cup to find ½ of a cup of cottage cheese. Then he patted the cheese into an approximately round pancake, divided it into quarters, and used three of the quarters. In this case, the cottage cheese itself served as part of the computation. The problem was broken into two parts, each of which could be solved by direct action on the cottage cheese. Pure, abstract arithmetic was never done. Very probably, the individual never knew, or cared, or needed to know that he was about to eat half a cup of cottage cheese.

Yet another illustration of the contrast between the out-of-school mode of functioning and the standard school mode comes from an in-school problem-solving session that is part of a study in which my colleagues and I are examining socially shared mathematics problem-solving among elementary school children. The children—fourth graders—were trying to solve the problems cooperatively. In one
problem, an ice cream cone could be bought for 60 cents, and some coins were in hand—a quarter, a dime, two pennies. The children were asked, "How much more do you need to buy the cone?" If taken as a real-world problem, the question would probably lead to a search through pockets for "round change"—a quarter, or, if necessary, dimes and nickels—to add to the quarter and dime already in hand. But because this problem was presented in school, it also could be interpreted as an invitation to do pure calculation—that is, to find the difference between the price and the total money in hand.

The children in our group interpreted the problem both ways and, in the process, unwittingly gave evidence of the normal lack of fit between the two. One girl, the best student in the group by ordinary school standards, immediately interpreted the problem in school calculation terms, did the subtraction in her head, and announced, "The answer is 23." This went unheard by other children who interpreted the problem in terms of coins and eventually figured out that, if one ignored the two pennies in hand, an additional quarter was needed to buy the cone. But the girl who had first worked out the subtraction answer did not want to give up her initial solution and, in an attempt to convince the group, proposed, "We could get change from out of the quarter," implying that they would then use only 23 cents of it! This proposal, although it preserved her role as the quick study of the problem solving group, helps to show how—at one level—school arithmetic and real world use of number knowledge do not map well to each other. Yes, one could get change for a quarter and then give the clerk 23 cents of it, along with the original 37 cents. But one never would. That would not be sensible behavior when buying an ice cream cone. As in the dairy plant and the weight watcher's kitchen, standard arithmetic seems to disappear in the real-world solution. Of course there is still, in this case, some number manipulation required—but not the kind that would place this problem in the subtraction chapter of a mathematics textbook.

Out of school, because they are continuously engaged with objects and situations that make sense to them, people do not fall into the trap of forgetting what their calculation or their reasoning is about. Mental activities make sense in terms of their results in a specific circumstance; actions are grounded in the logic of immediate situations. In school, however, symbolic activities tend to become detached from any meaningful context. School learning then becomes a matter of learning symbol manipulation rules and saying or writing things according to the rules. This focus on symbols that are detached from their referents can create difficulties even for school learning itself. For example, it can lead to systematic and persistent errors of a kind that seem virtually absent in practical arithmetic. Extensive studies of practical thinking in street markets, carpentry shops, construction sites, and the like (Carraher, Carraher, & Schliemann, 1985; see also Resnick, 1986) show people doing virtually error-free arithmetic, often applying principles of number composition and decomposition quite flexibly. Yet in school, children regularly invent "buggy algorithms" (Brown & Burton, 1978; Resnick & O'manson, 1987)—that is, written calculation rules with slight errors in them that produce reliably wrong results. These buggy algorithms tend to honor the rules for manipulating symbols (e.g., there are borrow and carry marks in the right places; all columns are filled with only one digit per column), but they violate basic principles of number. In the course of subtracting, for example, many children will "borrow" 100 from the hundreds column, skip the tens column, and "return" only 10 to the units column, an exchange that destroys the original value of the number and thus insures an incorrect answer. Yet when children are thinking about arithmetic without a need to do standard written calculation, they often demonstrate clearly that they know such an exchange would violate the constraints on exchanges among parts of a number (Resnick, 1986).

It seems that children treat arithmetic class as a setting in which to learn rules, but are somehow discouraged from bringing to school their informally acquired knowledge about numbers. This tendency for school knowledge to be disconnected from real life is not limited to mathematics—although it is particularly easy to draw clear examples from mathematics learning. The process of schooling seems to encourage the idea that the "game of school" is to learn symbolic rules of various kinds, that there is not supposed to be much continuity between what one knows outside school and what one learns in school. There is growing evidence, then, that not only may schooling not contribute in a direct and obvious way to performance outside school, but also that knowledge acquired outside school is not always used to support in-school learning. Schooling is coming to look increasingly isolated from the rest of what we do.

Generalized learning in school versus situation-specific competencies outside. Part of the reason for this isolation may be that schools aim to teach general, widely usable skills and theoretical principles. That is their raison d'être. Indeed, the major justification offered for formal instruction is—usually—its generality and power of transfer. Yet to be truly skillful outside school, people must develop situation-specific forms of competence. As we have seen—even in arithmetic, a curriculum whose usefulness is seldom questioned—the packages of knowledge and skill that schools provide seem unlikely to map directly onto the clusters of knowledge people will use in their work or personal lives. This seems true even for highly technical professional training. For example, one study (Lesgold et al., in press) has demonstrated that expert radiologists interpret X-rays using mental processes different from those taught in medical courses, textbooks, and even hospital teaching rounds. Another (Morris & Rouse, 1985) has shown that extensive training in electronics and troubleshooting theories provides very little knowledge and fewer skills directly applicable to performing electronic troubleshooting. Growing evidence of this kind points to the possibility that very little can be transported directly from school to out-of-school use. Both the structure of the knowledge used and the social conditions of its use may be more fundamentally mismatched than we previously thought.

On the other hand, situation-specific learning by itself is very limiting. As already noted, extensive studies of individuals with little formal schooling show how people can effectively perform work that includes extensive mathematical calculation. Some of these studies also document the limits of highly situated skills acquired in the workplace. Several demonstrate that when familiar aspects of a task change in certain ways—for example, when construction
foremen are asked to work with scales not used in their
culture (Carrather, 1986), or when bookies are asked to ac-
tect bets that cannot be calculated from their tables
(Schliemann & Acioly, in press)—unschooled individuals
have considerable difficulty and may fail entirely. Schooled
people do better, although they rarely use the supposedly
general algorithms taught in school. Instead, they invent
new methods specific to the situation at hand.

What Role for Schooling Then?
—And What Kind of Schooling?

I have identified four general classes of discontinuity be-
tween learning in school and the nature of cognitive activi-
ty outside school. Briefly, schooling focuses on the indi-
vidual's performance, whereas out-of-school mental work
is often socially shared. Schooling aims to foster unaided
thought, whereas mental work outside school usually in-
volves cognitive tools. School cultivates symbolic thinking,
whereas mental activity outside school engages directly with
objects and situations. Finally, schooling aims to teach gen-
eral skills and knowledge, whereas situation-specific com-
petencies dominate outside. What do these striking discon-
tinuities suggest about the relationships—actual and pos-
sible—between schooling and competence in work and daily
life? I consider this question from three points of view:
the role of schooling in directly preparing people for economic
participation, its role in preparing people to learn effective-
ly over the long course of their working lives, and its role in
preparing people for civic and cultural participation.

Outside the education profession, schooling and school
learning enjoy a very ambiguous status. We in the field take
for granted that formal education is good, that more of it
is better, that personal and national well-being depend vital-
ly on it. We are sustained in these beliefs by the evidence
of a century in which schooling has been an ever-expanding
enterprise, associated in fact and in rhetoric with modern-
ization, economic growth, and national aspirations. These
correlations seem to support the view that schooling pro-
duces economic benefits. Indeed, at present, claims of ed-
ucation's significant economic value are used to encourage
support of education and educational reform. Such claims
appear daily in the newspapers and undergird arguments in
professional periodicals and newsletters.

This economic valuation of education assumes that school-
ing actually produces economic benefits. But skeptical voices
argue that the causal relationship between schooling and
economic prosperity may run in the opposite direction. Ac-
cording to some, we have produced an arbitrary relation-
ship between academic success and life success by requir-
ing increasingly advanced school or college credentials
for work that does not really demand so much formal study
(Berg, 1970). Others argue that the economically advantaged
—whether individuals, regions, or countries—demand more
and choose to pay for more education; education is, thus,
more a consumer good than a vehicle for increasing eco-
nomic productivity.

The sociocognitive analysis of the contrasts between in-
school and out-of-school functioning that I have sketched
here suggests a more complex and interactive relationship
between schooling and economic efficiency. To see this rela-
tionship, we must first consider whether, and then how,
education functions to directly prepare people for specific
economic roles, their jobs. I propose that, while school is
probably an ineffective setting for job training, most cur-
rent on-the-job training solutions do not work very well
either. More effective forms of vocational and professional
preparation than now exist are needed—forms more closely
linked to job performance than those now customary. At
the same time, there is a broadly enabling role that school-
ing can play with respect to the economy—a role of prepar-
ing people to be adaptive to the various settings they may
encounter over the course of their working lives. Efforts to
play this enabling function are likely to result in new forms
of schooling that are also our best hope of preparing the
next generation to participate knowledgeably and effectively
in the civic functions of a technologically complex democratic
society.

Schooling and economic participation: The question of
job training. The simplest view of education as a means of
improving economic productivity treats schools and class-
rooms as places in which to prepare students directly for
jobs. Such training has been central to vocational education
since its inception. Ever since the Smith-Hughes Act of 1917,
schools have been expected to provide certain students with
experience with the same kinds of machines and the same
kinds of tasks that they will encounter in the workplace.
Whatever its merits may once have been, this kind of direct
job training in school is unsuited to today's conditions.
Apart from the classic criticism that such education curtails
opportunity by tracking some students out of high-oppor-
tunity and intellectually demanding curricula, the job
training vocational education agenda fails today because of
the sheer impossibility of preparing people for the quickly
changing requirements of specific jobs. The direct training
approach can only work when there is relatively slow
change in the technological and social structure of work and
when the equipment of the workplace can be duplicated
within the economic and safety tolerances of the education
system. Neither of these conditions holds today.

The obvious alternative to school-based job training is
training at the worksite. This was customary in traditional
apprenticeship, where a beginner in a field worked in the
shop or laboratory of an established expert and gradually
acquired various elements of skill. Although full-scale appren-
ticeships are not common today, Jean Lave's (1977) study of
tailoring apprenticeships in Liberia, where many of the tra-
tional forms still survive, provides an understanding of how
this kind of training works. Lave found that tailoring apprentices spend numerous hours watching
masters, journeymen, and older apprentices at work. From
the beginning, they observe both the full process of garment
production and the resultant product, and they practice a
few basic skills—pressing, cutting, using the sewing
machine. When they achieve an acceptable level of com-
petence in these basic skills, they attempt the entire pro-
cess of making a simple garment, such as a hat or drawers.
This task, repeated until mastered, is not practiced as an
exercise without economic significance; the apprentice's pro-
ducts may be offered for sale, although at a lower price than
the master's work. When construction of one garment is
mastered, the apprentice begins to work on another, more
complex garment and thus proceeds through a "cur-
riculum" that, while graded and sequenced, always ever-
cises component skills in the context in which they will be used. Although there is very little teaching—only occasional instructions or pointing out of errors by the masters—there is much learning through this graded, contextually embedded practice. There is also considerable self-correction, which is possible, according to Lave’s analysis, because apprentices, through observation, have established criteria against which they can judge their own products.

In America, the story of the rise of vocational education in the skilled trades is simultaneously the story of the decline of apprenticeship. As the ideology of expanded schooling took hold and the nature of the workplace changed, we gave up opportunities for learning in the workplace in favor of school-based vocational education. School-like forms of instruction now dominate even in many “on-the-job” training programs. In the military, in community colleges, and in proprietary training institutes, the classroom culture often dominates, and difficulties frequently arise in the transition to actual job functioning.

As an example, consider a military training program for aviation equipment maintenance experts (Susanne Lajoie, personal communication, April 1987). Trainees first take theory-oriented courses that provide no hands-on experience with equipment. Afterwards they are placed “on-the-job” to observe experienced airmen diagnosing and repairing equipment faults. They receive no sequenced practice and few opportunities to try their hands at diagnosis or maintenance activities in the manner of the Liberian tailoring apprentices. Those traditional apprenticeship activities seem to be precluded by the high-technology work environment. It may take hours or days to complete an equipment diagnosis, and some problems may not occur at all during the course of training. As a result, trainees cannot be exposed to the full range of conditions they will encounter as working technicians. In addition, the environment is dangerous and expensive if mishandled; it is not reasonable to allow trainees to make and then correct errors. Finally, neither the equipment’s functioning nor the mental activity of an expert equipment diagnostician is visible, as the master tailor’s physical activity and product are; so observation alone is unlikely to support the desirable and necessary conceptual development that occurs in the tailoring shop. The combination of school-type instruction, unstructured observation, and practice that is common in much technical skill training produces unsatisfactory results (Gott, 1984; Morris & Rouse, 1985). Many trainees never learn adequately, despite having mastered the classroom portion of instruction.

The story is much the same in management training. Corporate America, it is estimated, spends at least $40 billion per year on educating and training its employees, mostly for management functions. The size and dollar value of educational activities within corporations approach that of America’s 3500 colleges and universities. But when we examine the situation closely, we discover that in corporate education programs people typically go to classes, take tests, and proceed through a sequence of school-like activities. A recent Carnegie Foundation report (Eurich, 1985) labeled this venture of on-the-job training for managers “corporate classrooms”; such classrooms do not typically use the workplace itself as a learning environment. Although corporate classrooms have not been studied systematically, we can expect that they will share the advantages and disadvantages of school itself, despite more uniformly high motivation and up-to-date equipment.

Professional education, like technical training, has, over approximately a century, retreated from the place of practice (e.g., hospitals, law offices) to institutions specifically devoted to teaching. Universities have come to dominate professional education, partly because of burgeoning knowledge bases and partly to control standards for entry. The transfer has brought its own problems, however. There exists a continuing tension in all professional fields between theoretical and practical or clinical training. This tension is visible today in discussions of teacher education and certification. Some critics of current practices hold that no formal training in the art and science of pedagogy is required, that everything necessary can be learned through on-the-job teaching practice by an individual with deep knowledge of the subject matter to be taught. Even the staunchest defenders of formal teacher training (e.g., Carnegie Forum on Education and the Economy, 1985; The Holmes Group, 1986) call for a mixture of the theoretical and the practical (presumably provided by the school and the apprentice-like experience of student teaching respectively), but are not very specific about how the two parts should interact.

This analysis suggests that technical, management, and professional education are all suffering from too much adherence to instructional forms borrowed from the traditional classroom. There is inadequate engagement with the tools and materials of work, and more time is given to theoretical explanation than to building truly expert performance skills. New forms of training for competent functioning in various kinds of work need to be developed. Ways must be found to reintroduce key elements of traditional apprenticeship in forms appropriate to modern conditions of work. Since the technological and social complexity of modern work sites often makes it impossible to observe and practice in the traditional ways, special forms of “bridging apprenticeships” that use simulated work environments and specially designed social interactions may be beneficial. Such possibilities are being explored in some current research and development projects. For example, certain projects (e.g., Lesgold et al. 1986; Woolf, Blegen, Jansen, & Verloop, 1986) are developing forms of tutoring and coaching that reproduce many of the key conditions of apprenticeship in a computer-based simulation environment. The simulated apprenticeship environment acts as a bridge between the theoretical learning of the classroom and the actual practice of the work environment. In professional and management education, the case based teaching methods common in some institutions represent another kind of effort to bridge the gap between classroom and practice. To further develop these and other forms of bridging apprenticeships, programs of research on cognitive aspects of job performance are required.

Skills for learning outside school. Beyond reorganized job-specific training, modern economic conditions also call for education aimed at helping people develop skills for learning even when optimal instruction is not available. Such education is essential to prepare people to function well when “breakdowns” (cf. Winograd & Flores, 1986) in the customary structure of activity occur. Breakdowns—unexpected changes or difficulties that render the normal,
routine way of doing things inadequate—can result from equipment failures, changes in staffing patterns in a work site, new weather or economic conditions in a region, and the like. Such occurrences must be treated as normally recurring features of technologically complex work environments. When breakdowns occur, people have to do exactly what machines cannot: step outside the system and reason about it. People using various mechanized and computerized systems need to be equipped to recognize breakdowns, to work around them temporarily, to repair them, and, ultimately, to design better systems. For safety and efficiency in work, these capabilities cannot be limited to those "at the top"—the traditional decision makers, the engineers and system designers. Productive responses should be possible everywhere in the working system.

Cognitive research demonstrates that people work best with and within a complex system if they have a "mental model" (cf. Gentner & Stevens, 1983) of the system—that is, an idea of all its parts, what each does and how they work together, how changes in one part of the system cause changes in other parts. This mental model permits flexibility in responding to unexpected situations. It also provides a kind of insurance against actions that may appear to follow the prescribed routine or solve a local problem but will in fact cause difficulties—perhaps grave ones—somewhere else in the system. One important function of schooling is to develop the knowledge and mental skills students will need to construct appropriate mental models of systems with which they will eventually work.

Transitions into new work environments also require capabilities beyond those that can be acquired in situation-specific training. For example, studies of the nature of writing skill in different educational and work environments show how people who are considered adept writers in one context often are judged to be ineffective writers in a new context (Williams, in press). As a case in point, outstanding law students—those who successfully served on law review journals while in law school—often are judged poor writers when they enter law firms and must prepare briefing memoranda. New work situations and new performance criteria produce breakdown conditions in which established skills cannot be readily applied. Nevertheless, the educational experience of young lawyers aids them in crafting new skills suited to the new context in which they find themselves. Analogous breakdowns in normal skill patterns have been documented in studies of unschooled Brazilian craftspeople and tradespeople, and there, too, schooling seems to play a role in helping people adapt. For example, Schleiff- man and Acilis's (in press) bookies invented new procedures in the face of unfamiliar problems in rough proportion to how much schooling they had had.

We need to identify and closely examine the aspects of education that are most likely to produce ability to adapt in the face of transitions and breakdowns. Rather than training people for particular jobs—a task better left to revised forms of on-the-job training—school should focus its efforts on preparing people to be good adaptive learners, so that they can perform effectively when situations are unpredictable and task demands change. We can expect to succeed in this only through diversified research efforts on learning in out-of-school contexts. Through studies such as those cited here, we have begun to build a picture of how people actually work and function cognitively in their normal out-of-school lives. But these studies have focused mainly on experts—individuals functioning in smoothly operating work situations where they already know the routines and are skilled in using them. We what require now are studies of the development of competence in people who are becoming experts in their fields. We also must mount detailed examinations of people coping with situations of breakdown or transition in their work.

Most research on transitions in competence presently focuses on performances in academic domains. We know a good deal about the differences between good and poor students in reading, mathematics, and science, and between those who generally do their school studying effectively and those who do not (cf. Claser, 1987). This knowledge has begun to provide ideas for promising instructional programs to help weaker students acquire some of the capabilities of the stronger (Resnick, 1987). But we know little about how these findings translate to learning in practical settings or on the job. The evidence developed here on the discontinuity between school and work should make us suspicious of attempts to apply directly what we know about skills for learning in school to the problems of fostering capabilities for learning outside school. As long as school focuses mainly on individual forms of competence, on tool-free performance, and on decontextualized skills, educating people to be good learners in school settings alone may not be sufficient to help them become strong out-of-school learners.

Revising schooling: The civic and cultural functions of education. But perhaps school itself should not retain all the features that distinguish it so sharply from practical life. Indeed, evidence is beginning to accumulate that traditional schooling's focus on individual, isolated activity, on symbols correctly manipulated but divorced from experience, and on decontextualized skills may be partly responsible for the school's difficulty in promoting its own in-school learning goals (cf. Schoenfeld, in press). Modifying schooling to better enable it to promote skills for learning outside school may simultaneously renew its academic value.

In a recent study (Resnick, 1987), I undertook an examination of a number of programs claiming to teach thinking skills, learning skills, or higher order cognitive abilities. I looked for elements common to the successful programs that could point cumulatively toward a theory of how learning and thinking skills are acquired. I found three key features. First, most of the effective programs have features characteristic of out-of-school cognitive performances. They involve socially shared intellectual work, and they are organized around joint accomplishment of tasks, so that elements of the skill take on meaning in the context of the whole. Second, many of the programs have elements of apprenticeship. That is, they make usually hidden processes overt, and they encourage student observation and commentary. They also allow skill to build up bit by bit, yet permit participation even for the relatively unskilled, often as a result of the social sharing of tasks. Finally, the most successful programs are organized around particular bodies of knowledge and interpretation—subject matters, if you will—rather than general abilities. The treatment of the subject matter is tailored to engage students in processes of meaning construction and interpretation (e.g., Palincsar & Brown, 1984) that can block the symbol-detached-from-referent thinking
that I have noted is a major problem in school. Just such self-conscious meaning construction and interpretation skills are likely to be needed in conditions of breakdown and transition outside school, when one must use powers of reflection and analysis to craft sensible responses to new situations.

This set of shared features of successful programs for teaching thinking points to a conclusion that is, at first blush, surprising. When we begin to focus attention on thinking and learning abilities as goals of education, the distinctions between learning in school and out seem less sharp. The programs that appear effective in teaching school-learning skills have common features—such as socially shared mental work and more direct engagement with the referents of symbols—that are characteristic of out-of-school cognitive activity. This suggests a general need to redirect the focus of schooling to encompass more of the features of successful out-of-school functioning.

Such a redirection of educational effort should also have the effect of reasserting and revaluing the traditional civic and cultural functions of schooling. An efficient economy is not the only—perhaps not even the major—reason for institutions of education. “The chief reason for going to school.” Robert Frost once wrote, “is to get the impression fixed for life that there is a book side to everything.” (1972, p. 412). We can be sure that Frost’s “book side” does not refer to training manuals. But Frost may have meant what I have in mind when I speak of the civic and cultural functions of schools.

School is not only a place to prepare people for the world of work and everyday practical problems. It is also a place in which a particular kind of work is done—intellectual work that engages reflection and reasoning. In the best such work steps back from the everyday world in order to consider and evaluate it, yet is engaged with that world as the object of reflection and reasoning. If we value reason and reflection in social, political, or personal life, we must maintain a place devoted to learning how to engage in this extremely important process. School, at its best, is such a place. There, reasoning and reflection can be cultivated, and a shared cultural knowledge that permits a population to function as a true society can be developed.

It is difficult to stipulate what combination of ingredients makes a self-governing society effective. Certainly we cannot point to research on the cognitive capabilities needed for democratic participation of the specific kind that supports calls for reorganized technical and professional education. Yet we do, submit, share a vision of how a properly functioning democracy would look if appropriate education at appropriately high levels were to exist. This vision owes much to those of Jefferson, Dewey, and others who saw education as the cornerstone of democratic society—a society that bases decisions on maximum information and maximum interested discussion. Interested discussion, the opposite of turning decisions over to the experts,” means that the people most affected by any decision have maximum information and know how to use it. This is not a rationalist or technocratic society reaching “correct” decisions in cool and distanced ways. In this vision, people fight hard for what they want—which is often in conflict with what others want—but they do so using information and tools of persuasion in the expectation that those involved will listen to and analyze each other’s arguments. We imagine, in short, communities of reasoned discourse on public issues.

When we speak of the civic functions of education then, we envision a culture of reason, analysis, and reflection, based on certain shared knowledge. Realizing this vision will require a civic consciousness that goes beyond the individualist one of current classroom learning models and draws on models of shared intellectual functioning such as we see in our best work environments. Building such civic consciousness, by long apprenticeship in the special kind of community that only school has both the distance and the engagement to create, may be the most important challenge facing educational research and reform today.

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