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 contrasts which suggest that school is a special place and time for people—discontinuous in some important ways with daily life and work. Then, in light of these contrasts, I will consider 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 anthropologists, sociologists, and psychologists has examined cognitive performances in a number of practical settings. Cumulatively, this research highlights four broad characteristics of mental 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 performance 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 knowledge and skill has been provided by Edwin Hutchins (personal communication, April 1987), an anthropologist who has studied navigation practice in the highly technological work environment of U.S. Navy ships. The activity of interest 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 sightings on predetermined landmarks, using special telescopic devices mounted on gyrocompasses that yield exact readings 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 recorder, 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 projections of position are used to decide what landmarks should be sighted next by those on deck and when a course correction 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 actually pilot the ship, are needed by cartographers and gyrocompass builders. Thus, there is a further sharing of knowledge—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 outside. The centrality of tools in ship piloting suggests a second major contrast between cognition in school and outside. 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 physical 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 Acioly (in press) describe in detail how these bookies manage to operate a very complex lottery system, taking many different combinations of bets with varying payoff ratios, 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 a preloader, 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 never 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, Murtaugh, & 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 ⅔ 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 unheeded 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 & Omanson, 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'etre*. 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 (Carraher, 1986), or when bookies are asked to accept 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 between learning in school and the nature of cognitive activity outside school. Briefly, schooling focuses on the individual's performance, whereas out-of-school mental work is often socially shared. Schooling aims to foster unaided thought, whereas mental work outside school usually involves cognitive tools. School cultivates symbolic thinking, whereas mental activity outside school engages directly with objects and situations. Finally, schooling aims to teach general skills and knowledge, whereas situation-specific competencies dominate outside. What do these striking discontinuities suggest about the relationships—actual and possible—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 effectively over the long course of their work 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 vitally 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 modernization, economic growth, and national aspirations. These correlations seem to support the view that schooling produces economic benefits. Indeed, at present, claims of education'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 schooling actually *produces* economic benefits. But skeptical voices argue that the causal relationship between schooling and economic prosperity may run in the opposite direction. According to some, we have produced an arbitrary relationship between academic success and life success by requiring 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 economic 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 relationship, 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 current 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 schooling can play with respect to the economy—a role of preparing 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 classrooms 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-opportunity 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 apprenticeships are not common today, Jean Lave's (1977) study of tailoring apprenticeships in Liberia, where many of the traditional 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 competence in these basic skills, they attempt the entire process 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 products 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 "curriculum" that, while graded and sequenced, always exer-

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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, 1986; 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, Schliemann and Acioly'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. What we 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. Glaser, 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. At its 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, I 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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