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ABSTRACT

Changes in work and the workplace are transforming the kinds of knowledge, skills, and attitudes needed for successful work performance. Educators and school reformers are updating curricula and redesigning school programs to ensure that, in addition to academics, young people have opportunities to learn work-related skills and attitudes. A situative study of workplace skills that included case studies of students involved in building a transportation system and caring for patients at home demonstrated how worksite observation experiences enable students to learn needed job skills, "generic" skills, and work-related dispositions within the context of specific work cultures. The case studies demonstrated how skills become multi-dimensional when learned within the context of actual work and how contextualized learning promotes the ability to use information drawn from a range of academic disciplines to perform tasks and solve unique problems. Research has established the essential components for framing high school courses and/or programs around authentic tasks and apprenticeship methods and around teaching the following: complex reasoning skills, work-related attitudes, cooperative skills, job-specific knowledge, and academic knowledge. Contextualized learning requires that teachers do the following: become master practitioners among student apprentices; gain exposure to the world of work; and adapt their teaching to support authentic learning. (MN)

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Context Matters: Teaching and Learning Skills for Work

BY BETH GIDDENS AND CATHY STASZ

Employers are concerned that employees have "soft" skills in addition to technical knowledge and basic compentencies.

Why Should Educators Worry About Workplace Skills?

Changes in work and the workplace are transforming the kinds of knowledge, skills and attitudes needed for successful work performance. Evidence of the need for new skills comes from many sources. For example, The National Employer Survey conducted by the National Center for Educational Quality of the Workforce indicates that employers are concerned that employees have "soft" skills in addition to technical knowledge and basic competencies. In addition, a growing body of empirical research on the nature of work suggests that employers need nimble-minded workers to a larger extent than ever before. They seek intelligent employees who can master the technical demands of their jobs, work without constant supervision, adapt to new technologies, teach themselves how to use sophisticated equipment, and have the right attitudes and dispositions toward work. Being book smart is rarely sufficient. Employers and workers together note that "generic" skills, such as problem solving, communication, and the ability to work in teams are more important than ever.

If we consider that a majority of the labor market—three-fifths in 1992—does not have a baccalaureate degree, then it becomes clear that high schools, community colleges, and on-the-job training programs must play a key role in preparing the nation's workforce.

In recognition of the demand for a more comprehensive skills, policymakers and others have begun to develop new ways of defining and providing instruction in essential skills. These new approaches retain traditional academic high school courses but also include generic skills and job-specific vocational skills. In 1990, a commission assembled by the U. S. Secretary of Labor introduced a new skills framework. These SCANS (Secretary's Commission on Achieving Necessary Skills) skills are organized in a two-part framework: "foundation skills," including the basic skills of reading, writing, arithmetic and mathematics; and workplace "competencies." In addition, the federal government is currently supporting the development of skill standards in 22 industries.

Putting Skills in Context: How Academic Skills are Transformed at Work

Educators and school reformers are updating curricula and redesigning school programs at all levels to ensure that, in addition to academics, young people have opportunities to learn work-related skills and attitudes. Reformers also increasingly perceive that all

A Skills Glossary

Policymakers, researchers and practitioners have begun to use a number of terms to denote new skills—foundation skills, workplace skills, generic skills, workplace attitudes and dispositions. Here is a glossary of some of the more important skill terms.

SCANS Skills

SCANS skills come from the work of the Secretary of Labor's Commission on Achieving Necessary Skills. The Commission established four categories of skills thought to be required for most jobs: foundation skills, or basic reading, writing and arithmetic; thinking skills; personal qualities like responsibility and self-esteem; and, finally, five "work competencies." These competencies are (1) the ability to locate and use resources, (2) interpersonal skills needed for work, (3) the ability to use and communicate information, (4) the ability to understand and work within systems, and (5) the ability to use technology.

Basic Skills

These serve as the building blocks for future learning in school and life. They usually refer to the three Rs: reading, 'riting, and 'rithmetic.

Generic Skills

Generic skills are needed for most jobs. Typically, they include problem solving, teamwork, and communication skills.

Work Attitudes and Dispositions

These are dispositions toward work such as honesty, responsibility, reliability, willingness for employees to learn on the job and to take responsibility for their own learning.

Communities of Practice

A community of practice is the social setting in which work is situated. It refers to the kinds of teams that employees learn and work within, their daily routine and expectations of one another.

Skill Transfer

Skill transfer refers to the application of skills learned in one setting—the classroom, for instance—to a different environment such as a workplace. Researchers have learned that though many teachers, employers, and workers believe that skill transfer occurs automatically, that is not necessarily the case. Many young workers struggle to understand which academic skills need to be used to solve real-time work problems.

Situative View of Skills

From a situative perspective, the social setting in which cognitive activity takes place is an integral part of that activity, not just the setting for it. The knowledge, attitudes, or abilities needed for a certain job can be understood only within that particular working context, from the perspective of the individuals in the social setting.

students, not just those who traditionally enroll in vocational programs, can benefit from approaches that change both the content and process of learning. But many questions remain about the particular mix of skills that will be most rewarding to high school students and the best ways of teaching them.

One way to investigate the repertoire of skills workers should bring to their jobs is to study how workers actually do them, the social and physical situations they work within, and the range of skills they draw on to perform everyday tasks.

Two case studies from a situative study of workplace skills are described below (Stasz, Ramsey, Eden, Melamid, & Kaganoff, 1996; Stasz & Brewer, 1999). Although only half of the case studies are included here in narrative detail, findings from all four firms and all seven of the job categories that researchers observed will be discussed in this report. The researchers who conducted this study gathered data from observations, interviews, and documents collected at the sites.

Worksite Observation #1: Building a Transportation System

There may well be no more important public project in Los Angeles than the construction of a new subway system that will, over the next 30 years, cost an estimated $180 billion. Any project the size, scope, and complexity of the Los Angeles subway system requires meticulous planning and substantial oversight. Planning is the responsibility of a regional Transportation Agency, but three international construction firms are responsible for building the system. Between the agency and the contractors sit the project's contract managers: engineering firms assigned to individual "lines" of the system that must ensure that the construction firms and subcontractors build the subway in strict accord with requirements. On a day-to-day basis, quality assurance work on the subway falls to onsite construction inspectors and survey crews.

At one site, a survey crew is checking the construction of the "Orange Line," an elevated and surface-level rail line that will serve residents living south and east of downtown Los Angeles. It is almost finished—tracks have been laid, staircases installed, electrical hookups completed. On this day, a three-person crew begins its work with a visual inspection along the length of the track.

Once the crew's check is complete, they head to their van where the chief completes calculations that will enable them to perform a final quality control check for the line. The van, an "office on wheels," seats four and is furnished with a makeshift drafting table. Blueprints and maps cover a plywood shelf. In back, the van is piled high with equipment and tool boxes.

The crew chief sits at the drafting table, reviewing plans for the station and filling in a series of "elevation sheets" that show the position the track is supposed to have according to specifications. To determine these positions, the chief must use his "most important tool"—a hand calculator he has programmed to determine the placement of the rails to a one-eighth-inch tolerance, even when they have turns and subtle twists. These twists mean that the rails form a parabola, though the shape may not be visible to the naked eye. Without them, the trains would not be able to negotiate turns safely.

The track's position is measured in relation to "control points" set at a number of fixed locations. In addition to the twists, this site is complicated because the rails sit on elevated platforms more than 40 feet high. Consequently, the setting requires a series of calculations that check the rails' placement from three control points on the ground beginning at the nearest traffic intersection and then moving up to the elevated rail line. The chief comments that such sites and calculations force surveyors to develop an "algebraic mind" and the ability to place objects from two-dimensional maps and drawings into the three-dimensional world. While the chief works on the calculations, the two other crew members unload equipment for the day's work.

Today, survey crews use electronic equipment to do their work. The main tool is an electronic distance measurement (EDM) machine, commonly called a "gun." Mounted on a tripod, the EDM contains sophisticated electronic systems and a laser, permitting immediate calculation of elevations and distances for objects that are "shot" by the

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Reformers increasingly perceive that all students, not just those who traditionally enroll in vocational programs, can benefit from approaches that change both the content and process of learning.

operator. The "gun" must be placed in a precise location in relation to control points. Measurements are made in relation to a "traverse line"—a straight line between two control points. The second element in the survey equipment is the "back site," a reflective prism sitting atop a tripod over the second point on the traverse line that provides the base off which any objects within the 500-foot range of the EDM machine can be precisely measured. Measurements are made using the third element in the system—a "linker rod" that is placed on the object to be measured and then sighted through the EDM's viewfinder. The laser in the EDM bounces off the rod and back, where the EDM's electronics calculate the distance to the object. The crew compares these measurements to the chief's calculations to determine if the rails are in proper position. Measurements outside of tolerance mean the contractor must correct the problem.

The crew moves to the elevated station; each member assumes his position. The "chain man" uses a "plumb bob" to set the back site directly above a "PK" nail that has been driven into the concrete rail bed at a control point. The "instrument man" does the same with the EDM machine. Once the EDM is in place, the chief calls to the chain man over a walkie-talkie, directing him to the first measurement point. The chain man places the base of the linker rod on the marked spot, pulls a level from his tool belt, and checks that the rod is directly perpendicular to the spot. When the chain man calls "mark" over the radio, the instrument man tells the chief what the reading is. The chief marks the reading down and enters any variation from specifications in the elevation sheet. When the chief is satisfied, he orders the chain man to move to the next point, and they repeat the process until the 500-foot section of track on both rail lines has been checked.

Worksite Observation #2: Caring for Patients at Home

Wearing a white coat, an ID badge, and a stethoscope, Irene Simmons walks up to the door on the first floor of a small apartment building and rings the bell. After a few moments, a frail voice calls, "Irene, is that you?" A man in his late sixties opens the door. As a Licensed Vocational Nurse (LVN) working for a home health care agency, Irene has visited this patient once or twice a week since his discharge from the hospital two months ago. This patient is the first of five she will visit this day.

The patient has been diagnosed with end-stage AIDS. His home is cluttered, somewhat dark and stuffy. Near his bed in the living room sit a number of small tables piled high with pill boxes, tissue dispensers, blankets, and medical supplies. A television plays loudly in the corner. Although quite coherent, he is clearly fragile and ailing.

Irene's primary purpose is to monitor his condition. She begins by asking him a series of questions about his appetite, drinking, bowel movements, urination, and sleeping patterns. She helps him over to a scale and supports him as he steps up so he will not lose his balance. She compliments him on continuing to gain weight—his inability to do so previously is the primary reason the nursing case manager scheduled regular visits. Irene also uses a blood pressure cuff to check the patient's blood pressure, makes certain that his pill boxes are filled for each day over the next two weeks, and tells him that she is sorry to see an ashtray filled with cigarette butts in his living room—smoking is very bad for a person in his condition. After washing her hands, Irene thanks the patient and reminds him that she will be returning early next week.

Sue Perkins, a home health aide from the agency, greets Irene at the door of the next home. Sue arrived ten minutes earlier to bathe the patient, a woman in her early seventies. Irene notes that it is not uncommon for her to run into other members of the "treatment team" who work with these patients. When a patient is referred to the home care agency, a registered nurse (RN) conducts an assessment to identify which services will be provided to each patient. A single patient may have four or more service providers, including RNs, LVNs, home health aides, social workers, and physical, occupational, or speech therapists.

Sue helps the patient into the bathroom. The woman has very pronounced surgical scars on her chest, and has just had her left leg amputated below the knee. After placing a bath bench in the shower and testing its stability, Sue turns the water on and warms the seat. The patient moves next to the bench and, with Sue's assistance, lifts herself out of a chair and onto the bench. In the shower, she leads the woman through a series of range-of-motion exercises and checks her thoroughly for any marks or redness on her skin that may indicate injury or even abuse. A part of Sue's job is to report any new marks to the case supervisor. After helping the patient dress, Sue says good-bye and leaves.

Irene moves quickly through her check-up, asking the routine questions and checking the patient's blood pressure. She draws a small blood sample, which will be tested by the agency lab to ensure that the patient's medication is appropriate. After checking the patient's pill box, Irene says good-bye and departs, heading to a third patient's house just a few blocks away.

At Work, Skills Become Multidimensional

What can we learn from the work lives of these employees that will help high school students and young adults succeed? One observation is that these workers move through their days following a routine that enables them to accomplish specific tasks. Their actions are often simultaneously social, physical, and intellectual. Most important, they are always tailored to the task at hand. While they clearly use their technical and academic skills to do their jobs—as, for instance, the survey chief calculates construction tolerances and the vocational nurse draws on her knowledge of human physiology, behavior, and disease—these skills are used in concert with their ability to work comfortably with others, communicate effectively, and comply with outside standards. In effect, they work inside a specific work culture, and while doing so they exhibit vocational personalities (the survey chief's algebraic mind, Irene's commentary on her patient's smoking).

Social scientists call these work cultures communities of practice. This idea is useful to educators because it emphasizes the fact that, at work, skills are practiced as an amalgamation of knowledge, talents, abilities, behaviors, and values. Furthermore, the concept enables an investigation of the following questions:

- What level of academic skills is required by specific jobs and job contexts?
- Are generic skills and work-related dispositions evident in performing these jobs? How do workers conceive of these "soft" skills?
- How do skills and dispositions vary across jobs and work contexts?

An analysis of these issues will draw upon details from the case studies described above (Stasz et al., 1996; Stasz & Brewer, 1999), but also include information gathered at the other two firms of the study—a microprocessor manufacturer and a traffic management agency. Summary tables will present information gathered at all four firms. A total of seven jobs will be discussed, including:

- Survey inspectors at the transportation agency (TA) observed in the first onsite observation.
- Construction inspectors who assure that plan specifications are met during construction (TA).
- Licensed vocational nurses in the health care agency (HA) featured in the second onsite observation.
- Home health aides who provide basic patient care (HA), briefly encountered in the second onsite observation.
- Test technicians at a microprocessor manufacturing firm (MM) who test microprocessor chips and components to assure proper functioning.
- Equipment technicians who maintain, repair, and troubleshoot production and test equipment (MM).
- Traffic signal technicians who install, maintain, and troubleshoot traffic lights and systems at a traffic management agency (TM).

Academic Skills

The employees described in the field observations display a comfortable mastery of the academic underpinnings of their jobs. Of the seven

One way to investigate the repertoire of skills workers should bring to their jobs is to study how workers actually do them, the social and physical situations they work within, and the range of skills they draw on.

Table 1: Mathematics Skills and Tasks

JOBS	SKILLS	TASK EXAMPLES
Survey Inspector	• **Trigonometry** • Algebra • Geometry • Statistics	• Measures track and compares with design specifications
Construction Inspector	• **Algebra** • Geometry • Trigonometry	• Calculates distances and weights from blueprints • Checks construction projects for compliance with plan specification
Licensed Vocational Nurse	• **Basic math**	• Calculates flow of fluid in intravenous pump • Calculates percentages to check doses of medication
Home Health Aide	• **Basic math**	• Uses calculator to figure out mileage • Completes records
Test Technician	• **Basic math** • Statistics	• Calculates percentage (RPM) to determinehow long a test should run
Equipment Technician	• **Any math related to basic electronics** • Algebra • Statistics	• Plots and reads a pressure graph • Reads and understands output from statistical analysis (e.g., standard deviations)
Traffic Signal Technician	• **Any math related to basic electronics** • Algebra • Trigonometry • Calculus	• Computes resistance to determine which type of wire to install • Sets controller timing at traffic intersections • Reads and understands sine waves in oscilloscope

NOTE: Skills in **bold** are used more often and are more central to the work.

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occupations examined, five required algebra or higher mathematics; several required specific scientific knowledge. These findings concur with other research, suggesting that it is important for students to have "the ability to do math at the ninth grade level or higher" (Murnane & Levy, 1996). Math requirements for most of the jobs researchers observed exceeded ninth grade algebra.

The survey crew chief knows the math he needs to routinely calculate construction tolerances. Depending on the situation, these calculations can be straightforward or very complex, so he must be able to make them without fanfare or reference to instruction books. Inspectors also need sophisticated skills in reading blueprints, not only because a subway project yields a large number of complex drawings, but because they change frequently as the work progresses.

The LVN knows enough about human physiology and the prognosis of diseases to assess whether her patients need additional care from another health specialist. In addition, Irene is comfortable with the math skills embedded in her daily tasks: reading instruments, calculating dosages, checking IV drip rates, and tracking her car mileage. Similarly, technicians at both the microprocessor manufacturer and at the traffic management agency use a variety of math skills regularly throughout their work day.

The mathematics requirements for technical jobs run the gamut from very basic skills (e.g., adding numbers, calculating percentages) to complex applications of trigonometry (e.g., calculating spiral curves). Mathematics can be completely integrated within a discipline, as is the case with electronics, and therefore defined as part of the job. Or mathematics can be essential, but used infrequently, as is the case with the heath care aides. Though study participants often used familiar labels to speak about mathematics (e.g., algebra, trigonometry), they typically discussed mathematics in relation to operating specific equipment; rarely did they describe solving math problems in abstract "classroom" language. For example, when Irene described using percentages to figure insulin amounts, her math skills helped her follow a doctor's orders: "If the doctor says to give the patients 20 units of NPH [insulin], you have to know what—how is he using, what are his units? You have to know units in comparison to cc's or milligrams or what have you."

Table 1 shows the range of math skills our researchers observed and the tasks accomplished with these skills.

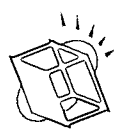
The transformation of book knowledge becomes especially evident for science skills and knowledge; technical workers also need greater specialization in science than mathematics. For example, survey and construction inspectors need a good grasp of electronics, while licensed vocational nurses must have a command of frequently prescribed medications and common medical conditions. Often, understanding the practical connection between two or more disciplines is just as important as knowing one field well. Surveyors must know enough about lasers and electronics to use and maintain EDM guns; similarly technicians at both the chip manufacturer and traffic agency need to understand how electronics and electricity converge in their jobs to perform testing and maintenance tasks safely. The "academic" science evident in these jobs is varied and often specialized; often, the science content of these jobs derives from several academic disciplines. According to a health care supervisor, an LVN's medical knowledge or technical skills are necessary, but not sufficient to perform the job; the key is "the ability to problem solve and to assess the situation yourself without input from anybody else."

Technical workers' application of scientific principles is firmly tied to technology or tool use. The survey crew use sophisticated measuring devices, and the LVN uses a range of medical instruments and devices. So in the application of a scientific (or mathematical) concept to a job task, workers draw on their ability to use sophisticated tools. These tools can be used properly only if workers know additional mathematical and scientific concepts—concepts that inform tool operation itself or that enable problem solving after measurements are made. A supervisor explained that traffic technicians need to be familiar with different kinds of semiconductors: "They have to have the expertise to know, not so much how to construct [a semiconductor], but they need to know the theory behind semiconductors, behind erasable program readable memories—that type of stuff. That's where the computer technology comes in."

It is impossible to discuss skills in technical jobs without referring to technology. The technologies present in the worksite studies make use of other disciplines, including mathematics, science, and communication, but technology can shape the nature of the skills needed. Obviously, workers need to learn how to operate and use the technology and to keep up with technology changes. But technology can also affect academic skill needs in different ways. Technology may make some academic skills obsolete; the extensive use of calculators serves as an obvious example. Alternatively, technology advances may significantly change the academic skill demands, as in the case of traffic signal technicians where digital systems replaced electromechanical devices. But it is certain that ties to the academic curricula or to the academic skills embedded in technology need to be made explicit.

Table 2 provides an overview of the science and technology applications most apparent in observations of workers in these jobs.

These findings suggest that many technical jobs demand a wide range of math, science, and technology skills; they also reveal that each job demands a particular mix of talents. Consequently, specialized training, either on the job or in classrooms, may be essential. Perhaps the only generalization possible about the academic demands of these jobs is that they all require employees to observe and assess situations from an educated perspective and to reason from facts, tests, and measurements.



"Generic" Skills and Work-Related Dispositions

Generic skills such as problem solving, teamwork, and accurate and appropriate communication are central to the performance of frontline workers. However, employers and employees use the terminology of generic skills (e.g., "problem solving," "teamwork") to refer to a range of behaviors and activities, which become specialized

At work, skills are practiced as an amalgamation of knowledge, talents, abilities, behaviors, and values.

according to a task, a worker's role in an organization, and the organization's culture.

PROBLEM SOLVING

Problem solving situations are similar for technician jobs, but different for inspection and health care jobs. For the equipment and traffic signal technicians who maintain, operate, and repair electronic equipment, problem solving mostly means troubleshooting. When the equipment or system breaks down, they must know how to troubleshoot—to identify the problem and fix it.

Problem solving for construction inspectors largely means quality assurance and control. A typical inspection problem occurs when an inspector identifies some discrepancy between the specifications and the construction and then must pinpoint the source of the discrepancy and determine how to correct the error. Survey inspectors view problem solving similarly. However, unlike any of the other jobs studied, survey inspection continually requires mathematical problem solving.

In contrast, problem solving for home health aides and LVNs is primarily situation assessment. The home care provider is the "eyes and ears" of a patient care team, where each patient represents a unique "problem." The home care workers gather information about a patient's condition, assess and interpret that information in the home care context, and report back to the case manager who can determine if the patient's condition warrants something other than the current treatment. In addition, the home health provider educates patients and household caregivers in ways that assist proper treatment—she solves (or even prevents) a problem by instructing family members about how best to administer medicines, feed, or even cheer up patients.

TEAMWORK

Teamwork is more than "just getting along." The study revealed three types of work organizations which require somewhat different team-oriented skills and behaviors (see Table 3).

Knowledge, skills, and sometimes authority may be distributed among team members. The survey team, for example, is comprised of individuals of different rank and skill, with the

Table 2: Science and Technology Applications

JOBS	SCIENCE/DISIPLINARY KNOWLEDGE	TECHNOLOGY/TOOL EXAMPLES
Survey Inspector	• Laser • Electronics • Hazardous materials	• Calculator • Global positioning system • Electronic distance measurement (EDM) • Back site • Linear rod • "Homemade" tools (e.g., level)
Construction Inspector	• Various specialties (e.g., concrete, electrical, metallurgy, communications, mining, mechanical) • Hazardous materials	• Basic tools (e.g., tape, square, level, calculator, safety equipment)
Licensed Vocational Nurse	• Basic assessment medications • Wound care • CPR	• Suction machine • Intravenous (IV) pump • Blood draw • Catheter • Portable Doppler • Ventilator
Home Health Aide	• Basic assessment (e.g., skin care) • CPR • Vital signs	• Blood pressure cuff, thermometer, stethoscope • Humidifier • Suction machine • Ventilator
Test Technician	• Electronics	• Centrifuge • Oscilloscope • Microscope • Specialized microchip testing equipment
Equipment Technician	• Hazardous materials • Electronics • Pneumatic • High-vacuum • Basic chemistry • Electro-mechanical aptitude	• Photo lithography machine • Acid processing machine • Microscope • Specialized manufacturing equipment (e.g., implanter, sputter, diffuser)
Traffic Signal Technician	• Electricity • Electronics • Hazardous materials	• Oscilloscope (digital and analog) • Digital millimeter • Basic tools (e.g., soldering iron, pliers, socket wrench, safety equipment) • Microwave communication • Portable computer

chief serving as the acknowledged leader. Similarly, home health providers are members of a team, which may include doctors, nurses, physical therapists, or other specialists. This team is characterized by both distributed knowledge and authority linked to special certification. It is key that LVNs and home health aides know their own areas of focus and authority as well as when they need to call on the expertise of more highly trained team members. They must function autonomously while simultaneously accepting oversight from others.

Teams can be formally recognized and supported by the organization, or informally constituted by team members themselves. Test technicians and survey inspectors work in autonomous, self-managing teams, with defined tasks and the authority to manage those tasks on their own. In contrast, construction inspectors operate as members of a "virtual" team that is not a formal entity, but a creation of the community of practice. Each inspector is responsible for inspections in one area (e.g., concrete, electrical); but the process works best when each is on the alert for activities at a site relevant to other inspectors' specialties.

Some work, of course, is independent. For the most part, traffic signal technicians and equipment technicians work independently, but they may form temporary teams to solve problems out in the field or to install new equipment.

Table 3: Characteristics of Work Groups

JOBS	AUTONOMOUS/ SELF-MANAGING TEAMS	KNOWLEDGE DISTRIBUTED AMONG TEAM	INDEPENDENT WORK
Survey Inspector	• Chief manages crew	• Chief plus two instrument men	
Construction Inspector		• Construction specialty	• Independent inspection, but informal, "virtual" team
Home Health Provider		• Patient care with many specialists • Distributed authority	• Patient care in home
Test Technician	• "Leaderless" team		• Independently performs tests
Equipment Technician		• May specalize in particular machines	• Independently repairs and maintains machines
Traffic Signal Technician			• Shop work • Team for short-term problem solving (e.g., emergencies)

DISPOSITIONS AND OTHER CHARACTERISTICS

The workers interviewed for this research were unanimous in the view that dispositions can "make or break" success on the job. They frequently mentioned the importance of attributes such as being hard-working, self-directed, or persistent. Beyond that, however, dispositions seem tailored to the work context.

Table 4 identifies three overlapping themes describing workers' notions about workplace dispositions: desirable traits, behavioral norms, and standards of performance. The theory in this area is not well developed. The classification in the following table represents an effort to begin to describe workplace dispositions. Desirable traits refer to characteristics that define dispositions desirable for a

Table 4: Dispositions and Other Characteristics

JOBS	DESIRABLE TRAITS	BEHAVIORAL NORMS	STANDARDS OF PERFORMANCE
Survey Inspector	• Loves a challenge • Attention • Cooperate • Anticipate problems	• Mutual respect • Reliance • Confidence • Prepared to work	• Professional standards • Assumes liability
Construction Inspector	• Manages people • Plans ahead • Deals with confrontation	• Know and do your own job • Ask for help	• Conscientious • Vigilant • Assumes liability • Integrity
Home Health Provider	• Independent • Tolerant of oversight • Accepts flexible scheduling	• Friendliness • "Bedside manners" • Patience	• Individual standard • Professional standard • Personal liability
Test Technician	• Flexible • Willingness to do repetitive work • Teamwork • Willing to learn		• Accurate and thorough
Equipment Technician	• Independent • Handles pressure • "Man over machine" • Flexible		• Individual performance • Affects productivity
Traffic Signal Technician	• Self-motivated • Tolerant of variable pace	• Don't pass problems off • Don't slack off	• Individual standard • Assumes liability

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job's basic tasks or for success within a particular setting. For example, unsupervised traffic signal technicians must be self-motivated to complete assigned work and must tolerate unpredictability such as when a regular day is turned upside down by emergency calls.

The community of practice defines norms of behavior for a work group. Survey inspectors, for example, described their team as an "intimate situation" in which members rely on one another in an atmosphere of mutual respect. Traffic signal technicians work independently under demanding conditions. For instance, each technician typically maintains about 100 signals, a significant load. In this environment, technicians can't slack off and maintain their performance. If a technician doesn't keep up with his maintenance schedule or doesn't solve the problems he encounters, other technicians will have to resolve them later.

Standards of performance also help define appropriate dispositions. Assuming responsibility is a serious business for inspectors, signal technicians, and home care providers because of legal liabilities attached to their work. The different standards held by inspectors and contractors, for example, create a natural tension on the job. Inspectors worry about quality control, and must negotiate with contractors whose incentives include completing a job on time and within budget. In this environment, inspectors must anticipate each inspection task, be vigilant, and be prepared for daily confrontations. Home health providers must meet the expectations of the supervising nurse and are also personally liable if their actions cause harm to a patient.

COMMUNICATIONS

Frontline workers' ability to communicate—both face to face or in writing—is key to their success. However, the complexity and sophistication of their communications often depend on whether they need to interact with internal, external, or multiple audiences. With the possible exception of home health aides, most workers communicate chiefly with internal audiences—members of their work group, other coworkers, and supervisors. Such a situation permits informality and the use of a technical vocabulary. Home health providers need additional verbal agility and patience to communicate with patients and their families about complex and emotionally charged health issues. On occasion, traffic signal engineers working in the field have to communicate with motorists, the "customers" of the traffic signal system.

By far the most common purpose for which technical workers use communications skills is to convey an appropriate fact accurately. Home health providers report on the status of patient functioning and log their own activities, including facts such as mileage driven. Survey inspectors call out measurements. The second most common purpose is to convey procedural information—instructions. Accuracy, speed, and clarity are highly valued in these instances.

An amicable and professional demeanor is highly valued in all spoken communications. Such a demeanor is perceived to improve the ability and willingness of the listener to engage in communication. This attribute is particularly important for jobs that require the worker to communicate directly with the public.

Among the study participants, construction inspectors needed the most sophisticated communication skills since they work in a potentially adversarial position to contractors. Inspectors negotiate with construction foremen when specifications are not met and ensure that the problem will be fixed without antagonizing the contractor and making future exchanges confrontational. This situation requires inspectors to "know how to talk to" contractors, to give them a fair hearing, and to maintain standards under pressure.

What Have We Learned About Academic Skills at Work?

The study results reported here (and documented in more detail in several NCRVE reports, including Stasz et al., 1996, and Stasz & Brewer, 1999) show that the relationship between academic knowledge and the work context is complex. Today's technical workers are expected to draw information from a range of academic disciplines and to use that knowledge to perform tasks and solve unique problems; often they must work proactively to identify potential trouble spots and design viable solutions without direct oversight or much advice. In short, technical workers are synthesizers of information, the exigencies of the task at hand, and work contexts; their jobs are as likely to demand creativity and intellectual dexterity as the ability to follow instructions or work precisely.

If we compare the traditional academic skill mix with the repertoire of abilities displayed by the technical workers interviewed in the study, it becomes apparent that few high school students graduate ready for the manifold demands of the workplace. Often, even strong vocational and academic programs overlook systems understanding or workplace dispositions. In addition, teaching students academic subjects in ways that help them use those skills later should be a key criterion of secondary curricula, since, as the researchers found, "knowledge transfer" is so critical to success. As one traffic signal technician explained, there is a big difference between classroom understanding and practical know-how:

> There are people who have studied and can study well and can take tests well. They are very book knowledgeable, but they can't apply it practically. Some don't have book knowledge, but are more hands-on oriented. They can go and read on what needs to be done and they are able to apply it. Or you can tell them. But they are missing the technical understanding. They may know every component inside, but they won't know what it does. Knowing it and knowing what do with it are two different things.

More and more often, educators will be asked to teach both kinds of knowing. New instructional frameworks will help educators incorporate some of the findings of recent skills research into academic courses, technical courses, and work-based learning programs.

Developing Frameworks for Teaching the Universe of Skills

This new research about skills (Stasz et al., 1996, and Stasz & Brewer, 1999) is limited to

Today's technical workers' jobs are as likely to demand creativity and intellectual dexterity as the ability to follow instructions or work precisely.

Table 5: Instructional Model for Teaching the Universe of Skills

INSTRUCTIONAL GOALS	CLASSROOM DESIGN	TEACHING TECHNIQUES	SCHOOL CONTEXT
Complex reasoning skills	Situated learning	Modeling, or demonstrating specialist skills	Access to knowledge
Work-related attitudes	Culture of expert practice	Coaching, or proving incremental instruction throughout a task	Press for achievement
Cooperative skills	Motivation for task spurred by students' intrinsic interest in project, rather than extrinsic factors such as a grade	Scaffolding, or providing students a framework for a task	Professional teaching conditions
Job-specific knowledge, skills	Cooperative work among students	Articulation, or having students describe how they approached a task	
Academic knowledge	Teachers establish master-apprentice relationship with students	Reflection, or asking students to compare their work processes to those of experts	
		Exploration, or finding a variety of ways to approach a task	

only a few occupations and cannot account for the skills needed for all technical jobs. Nonetheless, the study provides a rich picture of skills in context, especially the relationships among academic skills, work technology, and desirable workplace behaviors and dispositions.

Helping Students Learn to Improvise

It is clear, then, that context matters, especially in the sense that specialized training is often necessary for technical occupations, and in the exact mix of academic skills that workers draw on for their jobs. But context matters in another sense as well: A work setting determines the way employees use workplace skills like problem solving to facilitate a task. Paradoxically, although the way these skills are tapped also varies, exposing students to learning situations that mirror some of the exigencies of work (the need to recognize a practical problem, determine a means of addressing it, and carrying out a repair) may help prepare them for such challenges and responsibilities in many lines of work.

The reason is, simply, that technical work is often improvisational. To succeed at it, workers need to master a repertoire of skills and draw on them as they become needed. Because teaching students by way of authentic tasks is likely to help them develop the confidence to improvise on textbook learning or on terse job guidelines, classes designed around apprentice methods may be beneficial for all students, both those heading to college and to work. In short, learning the process of feeling one's way through a work problem to a solution can be used in many situations. Teaching this ability will help students understand and respond to particular contexts.

Contextualized Learning "Classrooms"

What are the essential components for framing high school courses and/or programs around authentic tasks and apprenticeship methods? Through extensive case studies, surveys, and ethnographic observation, NCRVE researchers examined the shared qualities of classrooms where the teachers succeeded in using a contextualized learning approach (Stasz, McArthur, Lewis, & Ramsey, 1990; Stasz et al., 1992). They found that these classrooms were similar in instructional goals, classroom design, teaching techniques, and school context. Table 5 describes the instructional model resulting from this research.

Perhaps the most telling characteristic is how teachers designed their "courses" so that students learned skills and knowledge by performing tasks that reflected the complexities of real tasks performed by adult practitioners. Typically, after an introduction to the "basics of a field," the students engaged in long-term projects rather than short activities. In most cases these projects were "situated" within a specific professional context, such as an electronics design lab, or a interior design business. However, in one class researchers observed an English teacher who created a successful framework for authentic practice by having students view themselves as college students required to do independent thinking and research. The classrooms promoted a culture of expert practice, simulating actual working cultures to varying degrees.

This contextualized approach was supported by broad instructional goals and by a master-apprentice relationship between teacher and students. Course goals exceeded delivery of academic or vocational training and included instruction (and encouragement) in complex reasoning, problem solving, and teamwork. The traditional authoritative role of the teacher was substituted with a looser hierarchy in which teachers assumed the role of experts who guided students through problems. In turn, students accepted the role of capable practitioner. Teaching techniques varied markedly from the lecture model. Since teachers were positioned as experts, they demonstrated their own approaches to tasks, coached groups on an as-needed basis, and offered limited assistance and advice. Consequently, students were more self-motivated; they realized that they controlled their success. An example of an apprenticeship electronics classroom is described in the box on page 15.

How Can Teachers Begin to Use Contextualized Learning?

Contextualized learning represents a marked departure from traditional didactic approaches to teaching. Consequently, reconstituting curricula to accommodate a contextualized approach presents most teachers and school leaders with a significant challenge.

Why? In short, many of the staples of secondary learning are altered or discarded in contextualized learning. Teachers who once knew the text inside out will need to become authorities in an entirely new way: They will need to become master practitioners among student apprentices. Students who needed only to study for tests will be faced with the prospect and excitement of solving unexpected problems. Predictable class hours will be replaced by meetings in which routines of practice are adapted to accomplish tasks.

It is clear, then, that teachers who want to use contextualized learning need tailored professional development opportunities. In an effort to supply such training, NCRVE researchers designed and pilot tested a six-week mini-sabbatical involving eight high school teachers in the summer of 1996 (Ramsey, Stasz, Ormseth, Eden, & Co, 1997; Stasz, 1997). The mini-sabbatical used the Classrooms That Work instructional model and was designed to meet four goals:

- Expose teachers to the world of work, including industry information, work cultures, routines, and experts
- Create high-quality, integrated curricula
- Adopt teaching roles to support authentic learning
- Support teachers' community of practice: planning, collaboration, reflective practice, new curriculum, and assessments

After training teachers to conduct a worksite observation, the researchers placed teachers in relevant workplaces for one week to observe how tasks and personnel were organized and managed. Teachers later drew from these observations insights into the culture of practice their class might adopt, the sort of tasks that might be selected for students, and the ways in which workplace skills affected productivity. An English teacher who observed work in the marketing department of a medical center reported the impact of his workplace observation in the following journal entry:

Reconstituting curricula to accomodate a contextualized approach presents most teachers and school leaders with a significant challenge. Teachers... will need to become master practicitioners among student apprentices.

Teachers need to practice new instructional skills like modeling, scaffolding and fading in a setting that is not as risky as their regular classrooms... trying new techniques and sticking with them for a long enough period to see that they could work.

> I saw a brainstorming session in which each person, knowing what they bring to the table, created a powerful example of people working together to solve a problem—to get out a simple message: the uniqueness of the cancer center... If I can create a curriculum with structures to allow students to bring to the table their experience and knowledge to work through a problem based on literature or media, it will feel great to transfer the creative chaos... to the classroom.

Next, teachers designed a week-long curriculum for contextualized learning projects that they "tested" on groups of eight to 10 students. Researchers found that the worksite observation, though brief, enabled teachers to improve their initial ideas for projects. For example, one CAD/technology teacher had initially intended to have his students build a popsicle stick bridge for their project. But after observing CAD operators in a metro transit authority work on actual designs, he decided to have them draw a plan for a bus parking lot on a real site and according to actual county specifications. This project supported many of the same skills as the popsicle stick bridge (e.g., teamwork, communication, and presentation) and technical skills (understanding spatial relationships, two-dimensional area planning), but it was no longer a mere exercise for students; besides being more "real" and more potentially useful, the task provided better opportunities for improvisational problem solving.

The worksite observations fostered other significant changes as well. Teachers displayed more sophistication integrating academic skills, generic skills, and specific competencies needed to carry out a project in their project-centered curricula. For instance, the box on page 16 describes a project where students need to make connections between school subjects and the unique demands of a particular task.

The pilot project's teaching phase also held many revelations for the teachers, even for ones with significant classroom experience. For the most part teachers had to recognize their reluctance to "let go" of teacher-centered instruction techniques. Fear of losing control was common. One life science teacher-trainer from a Math, Science, and Technology Magnet School explained:

> Old habits are hard to break and it's very hard for me to turn over the control of the class to the class. But I also understand that if I want them to be responsible for their own learning, I have to turn over that responsibility.

Such a comment shows that teachers need to practice new instructional skills like modeling, scaffolding, and fading in a setting that is not as risky as their regular classrooms. If taking such a chance during a mini-sabbatical is difficult, trying out new methods during the regular school year is likely to be more so. Teachers found they needed to become reflective about trying new techniques and sticking with them for a long enough period to see that they could work. A math and computer science teacher from a transportation career academy explained in his journal, "I am continuing to keep a low profile and am encouraging [students] to take responsibility for their work. I think it has a motivating factor because they can take *ownership* of the project and not feel that they are doing something for the teacher."

The experience led an English teacher to recognize that her connections between task, teaching approach, and assessment needed to be precise in order to maintain the authenticity of the project. If these components do not match up clearly for the students, her stated goals will not seem honest to them. Contradictions between these elements could undermine an otherwise strong curriculum.

These responses suggest that professional development specifically focused on contextualized teaching and learning is crucial to helping teachers redesign their instructional efforts to support learning and teaching generic skills in addition to academic and technical ones. At the very least, teachers will gain from their exposure to actual workplaces and use that new knowledge to design classrooms. Teachers also require assistance

An Electronics Apprenticeship

Mr. Benson, a vocational and math teacher at a comprehensive high school, designed his year-long electronics class using an apprenticeship approach. Although this class fulfilled an elective requirement for graduation, students received no academic credit for it. Students taking the class included ninth through twelfth graders. Because the number of math and science courses they had completed varied, the students did not have the same amount of background knowledge to prepare them for the specialized subject matter.

Mr. Benson's primary purpose was to teach electronics by integrating math, physics, and various forms of technology, including computers, robotics, stereo components, and circuits. He viewed electronics as an "integrated" discipline, drawing from academic subjects, specialized electronics knowledge and skills, complex reasoning skills, work-related attitudes, and cooperative skills. His instructional goals included training in all of these areas. He used electronics concepts and facts as stepping stones to project work, but did not emphasize disciplinary skills over generic skills.

The course labs and projects required students to develop complex reasoning skills by analyzing problems, generating solution paths, troubleshooting circuits and computer programs, and repairing broken or malfunctioning equipment. The course developed students' work-related attitudes by having them take responsibility for their actions, by asking them to work in pairs, and by encouraging them to pursue personal interests in their projects. These instructional goals set into motion conditions under which students thought about and practiced electronics at both basic and complex levels.

During the first semester, the class divided into pairs and trios of students who practiced the "basics" of electronics. These lessons were organized around individual labs that produced simple electronic devices. In the second semester, students worked on advanced projects that required students to use their basic skills and develop an interest in particular technologies. Their projects included advanced work on a robot using computer programs and remotes, further examination of basic lab experiments using advanced electronic workbench software, designing and building a sound system for use at school events, and designing and building electronic locks.

During the advanced phase of the course, Mr. Benson taught as a master to a class of apprentices. He often asked students to articulate how they were approaching problems as he "made rounds" among student groups during class. He modeled solutions to difficult situations and used examples from industry and from his own extensive hobbyist-level experience with electronics. In addition, when students were "stuck," he offered them frameworks (scaffolding) to help them find a solution and removed himself from the discussion (fading) once he felt students were back on track.

Instructional Design for a Contextualized Biology and Writing Task

Task:

Determine the suitability (e.g., physical, social, and technical) of the Metro Red Line for use by a person dependent on an oxygen support system.

Instructional Goals:

Generic:	Generate and evaluate assets
Disposition:	Persistence, ability to question authority
Domain skill:	Human biology of oxygen use, transportation of elemental oxygen, research organization, research theory

Classroom Design:

Culture of practice:	Students are consultants hired to lobby Los Angeles County Metro Transit Authority to accommodate dependent persons
Product:	Presentation to the MTA board
Teacher role:	Supervisor to the consultant
Team:	Scientist, writer

Teaching Methods:

Coach, model research, reinforce continuum of expertise, exploratory learning

Alignment with Official Curriculum:

Biology
Composition

Assessment:

A team of teachers evaluates the students as a group according to a rubric designed to capture all its aspects, including the quality of information, the completeness and coherence of the argument, the research methods used, the delivery of the presentation, and the creativity, sophistication, and formal correctness of the presentation materials.

developing new skills in planning, collaboration, reflective practice, curriculum development, and assessment. Not only are new skills required, old ones must be either integrated or unlearned to adopt a contextualized teaching approach.

Educating Workers for the New Economy

The last quarter-century has seen many jobs and workplaces transformed by technology, and the rate of change shows no sign of slowing. Succeeding in this environment will mean that workers need a firm foundation in basic skills, the sophistication and focus to work productively in new workplace cultures, and the ability to learn new skills and master new technologies throughout their careers.

How can the nation's educators hope to prepare students for jobs not yet in existence, with tools now being invented, and in industries only recently developed? Part of the answer lies, we think, in improving educators' understanding of the challenges of today's technical jobs—and in helping them find ways to provide students with a basis in and an awareness of the types of skills workers will need, from academic and technical to generic workplace competencies.

Professional development specifically focused on contextualized teaching and learning is crucial to helping teachers redesign their instructional efforts to support learning and teaching generic skills in addition to academic and technical ones.

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