Literacy and Numeracy
in a Changing Workplace

by

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Educators are increasingly challenged to provide students with the skills they will need in the workplace. However, much of the research designed to determine what those skills are has been done from a distance, through surveys and quick tours of workplaces rather than close observation of work. Here Mark Jury and Mira Katz, doctoral students in Education in Language and Literacy at U. C. Berkeley, take a close look at literacy practices within a high tech, multicultural workplace. They call into question the popular characterization of workers as "deficient" and needing a dose of "basic skills." Their work is part of an ongoing study comparing literacy practices in a traditionally organized and a more "high-performance" workplace. The project is directed by Dr. Glynda Hull, a researcher for the National Center for the Study of Writing and Literacy and a leader in the field of workplace literacy issues.

Not long ago, browsing through messages on one of the many on-line discussions of education and work, we ran across the following lament from the owner of a small management consulting firm:

My clients have employees that can't read, write, reason and complete the most basic math functions.... School systems have not and are not doing their jobs. It is as simple as that. The young people today are not prepared for the challenges of today let alone tomorrow. We are in serious trouble in this country. We are losing our manufacturing base and it will only get worse.

The consultant's concerns certainly are not new. They echo a decade — some would say a century — of reports by government commissions on the skills of the current and future workforce. In particular, as the number of women, people of color and immigrants entering the workforce has increased, so have comments about "skills deficits" and a lack of workforce preparedness. Of course, we're in no position to question the experience of the consultant or his clients. We would, however, like to offer an alternative view which has grown out of nearly three years of observations in two large, high tech, multicultural workplaces undergoing organizational change. We want to present a close look at some of the literate practices in one of these workplaces, hoping to challenge popular assumptions about workers and about the skills they are said to need. Perhaps this in turn might challenge parallel assumptions about the changing populations in American schools.

First, a little background on the study. Our research began in the context of widespread concerns, like those of this consultant: U.S. workers are ill-equipped to compete in the global marketplace. The claim was that in order to be competitive, American industries had to adopt new technologies and new forms of work organization labeled "high performance."

The time had come, it was said, to throw out the "Tayloristic model," the form of work organization developed by the American engineer F.W. Taylor about 90 years ago. Taylor presented an industrial configuration in which workers were trained to perform simple repetitive tasks. It was presumed that when the model was working as it should, workers would check their minds at the door and leave the thinking to engineers and managers. By contrast, the high performance model is one which, at least in theory, gives responsibility to the workers who then become active participants in work-related decisions.
Critics say that if the high performance model is the goal, schools must help students develop knowledge and skills necessary for success in restructured, technologically sophisticated workplaces.

Many large companies have adopted some of the trappings of "high performance," but in piecemeal fashion, leaving the organization of the workplace and the daily lives of the workers largely unaffected. The rarity, however, is the company which genuinely attempts to rethink itself, to change its workplace culture, to reorganize in ways that affect all employees' work practices and skill requirements. We'll focus here on one such company.

This company, which we'll call "Teamco," contracts to manufacture circuit board assemblies, the fastest growing and one of the most competitive branches of the electronics industry. Teamco is headquartered in California's Silicon Valley and has plants worldwide. The workplace is multicultural — the majority of workers are Chinese, Vietnamese or Filipino, although many other ethnicities are present. Some of the workers have completed only a bit of elementary school, while others have advanced degrees. Since most have never been to an American elementary or secondary school, this article should not be interpreted as a comment on whether or not American school systems are "doing their job." Rather, we want to understand how this company's shift toward a high performance workplace is changing the kinds and uses of literacy, numeracy and oral communications skills that production workers need to function successfully at work.

Because Teamco's reorganization involved a substantial increase in the kinds of reading and writing workers engaged in, we had the opportunity to compare supervisors' assumptions about workers' literate skills and knowledge with what workers actually did. This comparison confirmed for us the need to analyze literacy skills in relation to the contexts in which they occur. Work is never simply a set of tasks; it is also a set of social relationships from which tasks cannot be disentangled. Our research also calls into question the notion, seen so often in the various skills lists which accompany commission reports, of literacy as a set of "basic skills" — which tends to reduce reading and writing to discrete and isolated tasks. Our work emphasizes instead the contextual nature of literacy practices in both school and the workplace.

In the next two sections, we describe portions of two events: first, a Self-Directed Work Team (SDWT) meeting, then an overview of a goal review process. We offer these two events to provide a glimpse of the degree to which literacy practices pervade the organization of work in this electronics factory.

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A Self-Directed Work Team Meeting
On a Wednesday afternoon in mid-April, a group of 23 workers clad in white, knee-length company jackets, all members of the Final Mechanical Quality Assurance Team (Team 21), push into a cramped conference area on the factory floor for the team meeting. In a tiny space consisting of several five-foot-high moveable cubicle walls, some workers are seated at an oblong table, but many must stand. As team members arrive, each one picks up a copy of the meeting minutes and the agenda stacked on the table nearest the entry. While they wait for the meeting to convene, workers quietly peruse the two-page document. Team 21 supervisor Rachel Solarzano, a thirtyish European American who has worked at Teamco just over two years, makes notes about issues that need to be taken up with the group. When all members of the team are present, Rachel asks QA team leader April Nguyen, a petite, shy Vietnamese woman with graying hair, to read aloud the previous week's minutes and this week's agenda. Team members follow along.

Next, three members of the Final Mechanical/Final QA (which includes five production lines) report on problems in their respective areas.

In English heavily influenced by his Japanese roots, Toshio Kogawa animatedly describes difficulties with boards coming from another line — Second Handload. Toshio and his coworkers are receiving boards with a tilted component, which is problematic because it conflicts with the protocol outlined in a complex
written document known as the MPI (Manufacturing Process Instructions). The MPI indicates that the component must be soldered flush with the board, which Toshio reports is often not the case—a problem which warrants the team’s collective attention.

The following excerpt of Rachel and Toshio’s conversation is typical of the manner in which problems are presented at Team 21 meetings and provides a sense of the exchanges that occur between the team supervisor and the line workers. The latched, overlapped nature of the dialogue reflects the relaxed feel of the meetings, and the exchange also gives some indication of the significant kinds of language learning opportunities that occur regularly in the Teamco context. Below, latched turns (where no break occurred between two speakers’ utterances) are marked by two equal signs, and overlapped turns (where speakers talk simultaneously) are indicated by brackets. Capital X’s mark inaudible syllables.

Toshio: Eh, we got problem on uh 606. Eh? So Second Handload they got push their ICs up. They reconnected here (motioning with his hands). The XXX by the middle push down the part.

Rachel: Okay so what you’re saying is [the ICs]

Toshio: [XX this way. Yeah.]

Rachel: == are tilted? ==

Toshio: == Yeah. Still high ==

Rachel: == So the leads weren’t flush [into the board?]

Toshio: [yeah]

The dialogue continues in this vein.

Through Rachel and Toshio’s lively exchange, peppered with hand gestures which mimic the physical relationship of the component to the board, the two come to a clear understanding of what the problem is. Rachel thanks Toshio for bringing it to her attention, and she promises to look into it.

Next, Binh Tran, a young soft-spoken Vietnamese worker on the Final Mechanical line, gives an account of difficulties in his area. As he does so, he reaches into his pocket and pulls out a piece of paper from which he reads for the duration of his presentation. The group listens attentively while Binh lists the difficulties he is aware of while Carlotta Bonilla, a Filipina in her early twenties, takes notes. When Binh finishes, several members of the group applaud his thorough account.

Jorge Garcia, a middle-aged Mexican American worker from Final Mechanical, also reports on problems. He informs the team that his line is getting boards with loose or missing nuts and washers. Rachel asks if either he or the lead from his area is communicating verbally or in writing about this issue with the First Mechanical line, whose work precedes that of Final Mechanical. When repeated problems such as this one occur, often a written report called a Corrective Action form is filled out to document problems between production lines.

Following these reports, Dolores Aguilar, a health and safety inspector of Mexican American descent, reads the CSI (Customer Satisfaction Index) report to
the group. The report, which comes weekly from Teamco’s customers, “grades” the company on quality, communication and delivery. Today, as usual, the grades are mostly A’s and some B’s.

It is now Rachel’s turn. She reiterates her expectation that all team members will be at team meetings on time, and she commends the team for their hard work and discipline. She asks if everyone is using the Total Quality Management (TQM) forms passed out at the last meeting, and Dolores suggests that they spend some time discussing TQM. Rachel explains that the five team leads on Team 21 are supposed to fill out the forms indicating quality problems when they arise. The new forms of tracking that TQM requires mark an increase in the literate responsibilities of workers that has occurred recently with the company’s shift to Self-Directed Work Teams.

As the meeting comes to a close, Final Mechanical lead Joyce Castro, a Filipina in her late forties who taught first grade for 20 years in the Philippines before coming to the United States, has some advice for her fellow workers. She tells the team that workers who find themselves with nothing to do should contact one of the team leads who will find a job that needs doing. “So you have to tell us you have nothing to do. [Say to them,] ‘Give me a job. You got a job for me? Don’t just go home and say there’s nothing to do.’” Rachel is surprised that some workers leave early. She says that the worst thing is to clock out without being paid for the full eight hours. Even if it means doing paper work in her office, she says, there is always something which needs to be done.

Finally, Rachel reminds people that although Team 21 is divided into five lines, each serving a different customer, that technically everyone should be able to work anywhere in the Team 21 area. She urges those who want to cross-train for another line to speak with her, reminding the group that the building supervisor “totally backs cross training.” She adds, “It’s gonna happen anyway. The more you learn, the better off you are to the company.”

The meeting described here is typical of Team 21’s weekly meetings in its uses of literacy, its opportunities for language learning and its emphasis on problem solving. Although over 90% of Teamco’s workforce is comprised of nonnative speakers of English, reading, writing and problem solving in English are an important part of what workers do every day. They read and write meeting minutes and agendas; they receive important information from both customers as well as from internal sources about their team performance. Out on the work floor they must refer to the Manufacturing Process Instructions for a wide range of different boards made by the company, and they must also document defects as a means of tracking their quality and productivity, using data they collect to keep a running tab of team performance on a weekly basis. Workers order parts from the stockroom by filling out order forms, and they keep track of how many and what kinds of boards are finished by their line. Some track inventory on the computer, entering data which will be used by the team and the managers to calculate goals. Clearly, these workers employ daily a wide range of literacy skills.

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Since so many of the workers speak English as a second language, interactions occurring in English, whether spoken or written, present an opportunity for language learning. Toshio and Rachel’s exchange, in which talk and gesture are co-mingled, typifies the kind of linguistic assistance and opportunities for increasing language skills available to employees everyday. Because the workforce represents such a variety of cultures and languages (the company estimates that collectively its employees speak over 18 languages or dialects), English is the common workplace language. While workers of similar backgrounds converse and write notes to themselves and one another in their native languages, they are not only able but are obligated to function in English for cross-team and cross-area communication.

In addition to being a literacy-rich and linguistically-rich environment, Teamco is also a place where workers must solve problems in a variety of ways. The
accounts of Toshio, Binh, and Jorge demonstrate how important the ability to identify problems is to this factory's work process. Such problem solving is an integral part of Teamco employees’ daily work life. Negotiation among team members and across teams is essential to Teamco’s success, and line workers must be able to reconcile differences between the boards they receive on the floor and the complex written instructions (the MPI's and other documents) that are so central to Teamco's work organization. Doing what the job requires is not always simple, and making reality (boards, for example) conform to the required written specifications takes an enormous amount of ingenuity as well as an informed appreciation of the problem.

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However, at the same time that there is considerable effort to involve production line workers in the problem solving processes of the workplace — processes in which literate practices are heavily embedded — there are also constraints on the ways in which workers can participate in such activities. This is illustrated on Team 21 by the fact that while Toshio, Binh, and Jorge are sincerely appreciated for bringing problems to their supervisor’s attention, they are not in positions to solve the problems they perceive but must instead rely on their leads and supervisor to consult with other lines within the factory. In this sense, although front line workers are invited to take on more responsibility which requires them to make use of extended literate and critical thinking skills, the traditional hierarchy which shuts workers out of the authoritative loops of power within the factory's work processes is largely maintained.

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The Goal Setting Process

On another occasion in April, two dozen white-smocked workers gather for a Goal Review Board meeting in the Ivory Room, a square meeting and training room off the production floor next to cubicles of buyers and marketers. Made up of production workers and supervisors representing the plant's eight functional areas, the Review Board has asked team representatives to share their quarterly goals for productivity and quality, to present data showing progress toward those goals, and to explain how they measure that progress using productivity and quality calculations.

The board members and presenters sit at three rows of tables facing a whiteboard, overhead projector and projection screen. On the wall to their right is a company poster highlighting “The Five Basic Principles Of Teamwork.”

Joanne Peterson, a quality engineer and facilitator of this meeting, has asked Mateo Bulosan, an industrial engineer, to start the meeting by explaining “standard time” — the time a particular work process is expected to take. Workers have been asking who sets this standard time and for what purpose. Bulosan addresses these questions and explains how standard time is used in calculating a team’s daily productivity. As he speaks and writes examples on the board, some of the workers pull calculators out of their smock pockets and check his calculations. Others jot notes, read over forms, look at the screen, back at their notes, and then confer with each other. Some appear to pay little or no attention and instead try to finish the overheads for the presentations they will make later in the meeting.

Following Mateo’s explanations and an extended question and answer period, Xheng Qian is called as the first team representative to present. A high school geometry teacher in China for 14 years before immigrating to the United States in 1983, Xheng has been working for Teamco since 1986. She started at First Mechanical screwing brackets to boards, snapping on components, and sticking on bar code labels. Currently she is the team leader in the setup area for the SMT (surface mount technology) lines. She and her coworkers load “feeders” with tiny resistors and capacitors.

Though recently recommended for promotion to swing shift supervisor for the SMT area, Xheng turned down
the offer, telling her supervisor that she didn’t think her English was good enough. While she feels her English is fine for her current work, she’s afraid that as supervisor she will have to speak with customers and doesn’t feel confident enough for that. She did tell the supervisor, however, that if he were to recommend her again when the next opportunity came up, she would be ready.

Standing at the front of the room and reading from the overheads she has prepared, Xheng summarizes her team’s data collection process and their quality and productivity calculations. She is aware that the company wants teams to measure their quality in terms of parts per million (PPM) — that is, a weekly average of the number of defects or rejects per million units. In her area, each loaded feeder is a unit, while in other areas each part placed on a board is a unit. The fact that the units measured are so different puts her team at an unfair disadvantage. Xheng knows that in an area where workers place thousands of components on boards each night, the average number of defects per week might be only 50 PPM, significantly lower than in her area where they load only a few hundred feeders each night. She is concerned that her area will look bad if forced to use PPM as a measure of quality. This concern is heightened by a new policy linking quarterly bonuses to the team’s performance against their goal, and by the new practice of displaying printouts of quality and productivity charts on the wall by the time clock in the busy hallway between the manufacturing floor and the cafeteria.

Before presenting her quality data, she argues for a different measure for her area, preferring to record the percentage of feeders loaded without rejects:

Xheng: The quality, I think the self-feeder we cannot use the PPM. Ah, we use the percentage is better. Because ah, okay, example [She walks over to the whiteboard and picks up a felt pen.] Every day the average four hundred feeder we set up. If one reject, if use PPM. [She pauses to write the following on the board.]

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\text{PPM: } \frac{1}{400} = \frac{X}{1,000,000} \\
X = 2500 \text{ PPM}
\]

Four hundred, four hundred feeder, one reject, we get a two thousand five hundred PPM. Very bad quality, right?

Joanne: Oh, but you don’t have to worry about the number.

Xheng: [She writes “%:” on the board and then continues.] If use percent that’s better, I thinking. Okay ah, one reject, four hundred feeder, right? By hundred percent we can get ninety-nine point seven five. [As she talks, she writes the following equation on the board.]

\[
\text{%: } (1 - \frac{1}{400}) \times 100\% = 99.75\%
\]

Very good quality [laughs]. Right? Yeah. We use percent, better. Okay. That’s what I think.

Joanne tells Xheng that she need not worry about the specific number of defects, but that her team should focus on the team’s quality trend. Besides, she tells Xheng, her team doesn’t have much choice since the
company’s database is set up to record PPM as the measure of quality. And again, because that is what the company database is set up to record and print out, that is what is displayed on the quality/productivity charts. Her team’s charts, tacked up in the busiest area in the plant, appear to show quality defects at a rate five times the average of the rest of the teams.

As it turns out, Joanne’s suggestion to Xheng that “you don’t have to worry about the number” proves a bit naive, for in a site-wide goal review meeting later that quarter, the company executive overseeing development of SDWTs tells the site coordinators that teams must revise goals he has assessed as “too low.” Xheng’s team is among those required to revise their goals. Justifying his assessment of the goals, the manager has noted on the goal sheet, “no evidence of progress.”

Due to the nature of PPM Calculation and infrequency of occurrence (sic) of reported defects, and low denominator (Quantity of feeders setup) each occurrence of a defect is above 3 standard deviations above the average, and exceeds UCL [upper control limit]. This creates instability in the data. Our goal will be 275 PPM ave. week (Best 10 out of 13 weeks) which is 45% lower than Q4-95 Goal.

In this analysis Dean and Xheng opt to highlight the significant difference between the two goals rather than the difference between past performance and the new goal. The goal is approved.

Admittedly, the complicated calculations that Xheng and her colleagues engage in here are not every day practice at TEAMCO. More typically, the calculations Teamco workers are asked to perform at the end of each shift often involve little more than simple tallying of assemblies or components or defects, tallying which yields numbers to fill in blanks on forms handed over to supervisors. Lead workers are required to do some multiplication and division according to the company’s formulae to determine productivity and quality data. But as Xheng’s foray into the Teamco world of mandatory goal setting suggests, this simple tallying and filling in of blanks are only a small part of the numerate practices in this workplace. These practices require an analysis of the settings in which the calculations are embedded and an understanding of how they are inextricably linked with particular literate practices within the company.
how these numbers will be interpreted, by whom and toward what end. Even further, Xheng shows the importance of workers knowing alternative formulae and understanding various uses of calculations. Her argument depends on her knowledge of how to present data orally and in writing, and how to make a case with numbers.

In preparing a goal which accurately and fairly represents a complex work process to managers and others removed from the day-to-day operations on the floor, Xheng and Dean demonstrate the importance of being able to work with the simplified, standardized forms and the systems of measure imposed on them by the company. This has gained particular importance since team bonuses are based on performance against a company-approved goal, and management expects “evidence of progress” from quarter to quarter.

Discussion
A few things bear comment in closing. First, a caution against some of the popular notions about teams and the changing workplace. There is much vague, romantic talk about workers “thinking for a living” and being “empowered” through teams. And in some ways we have contributed to that talk by choosing in this article to focus on Team 21 and Xheng. While it’s true that Teamco’s efforts to reorganize have involved some employees working in new and different ways, Teamco is no worker’s utopia.

In this new workplace, workers are invited to take on more responsibilities, many of which are embedded in literate practices, without being offered any real shift in the ability to shape their work environment. In fact, it is our sense that the workers’ new literate responsibilities at Teamco have increased both their accountability and the degree to which their work is monitored by managers and supervisors. In sum, the invitation to “think critically” and be “empowered” has been accompanied by a degree of micro-management that many workers find stifling, if not also antithetical to the team process.

As the stories of Toshio and Xheng suggest, people negotiate work in creative ways. Contrary to the conventional wisdom which presumes that workers don’t currently “think for a living,” we have observed both critical and creative thinking at Teamco. Some of this is recognized and rewarded by management, but much of it is an unacknowledged part of the daily operation of the plant.

We have observed workers of a wide range of ages and from varied cultural, educational, technical and professional backgrounds draw on multiple forms of representation — talk, mimitings, drawings, demonstrations, models, mathematical calculations, written documents — to get work done on schedule and with a high degree of quality. We have also, however, observed problems on the production line: conflicts, mistakes, and miscommunication. We have seen blunders of all kinds — including blunders by engineers, supervisors and managers, which entry level workers, when allowed, are left to correct or to circumvent. Nonetheless, we object to the indiscriminate negative characterizations of workers reflected in much research on the workplace and in the popular discourse about work and workers’ skills and knowledge.

What does any of this have to say to schools? At a time when some school-to-work initiatives focus their efforts on constructing industry skills standards and linking them to school curricula, it might be tempting to extract from Xheng’s goal setting experience, for instance, a tidy little student learning objective: “Given a formula for calculating quality and productivity, the student will be able to gather data, plug appropriate numbers into the formula, and record the products on the worksheet.” But this grossly understates what’s involved in Xheng’s analysis of and solution to the problem, a solution which included extensive collaboration.

More important than any static set of skills are schools and workplaces which honor negotiating, [and] which nurture multiple perspectives...

What we regard as “basic” needs to be questioned. What’s “basic” in Xheng’s instance has much to do with her ability to read the organization, to understand the power of numbers, to negotiate the company’s social network, and, in doing so, to shape a collective resource that helps her act upon a certain problem in a certain context. Her facility with particular mathematical functions helps shape and at times direct that collective
resource, but that facility by itself was not enough to get her team's goal accepted. Nor should we overlook her "basic" understanding that "get the goal accepted" is another way of saying "get management to acknowledge the level of quality and productivity her team has already achieved and maintained."

Team 21's example suggests something other than the currently popular approach to teaching "workplace skills"—that is, teaching discrete units in Effective Listening, Reading for Information, Locating Information, and so on. What's essential for Toshio, especially in this text-saturated workplace, is not simply knowing how to read manufacturing process instructions but also knowing when and how to negotiate around documentation to get work done.

The multiple demands of workplaces such as Teamco—high-tech, multi-ethnic workplaces in rapidly shift-