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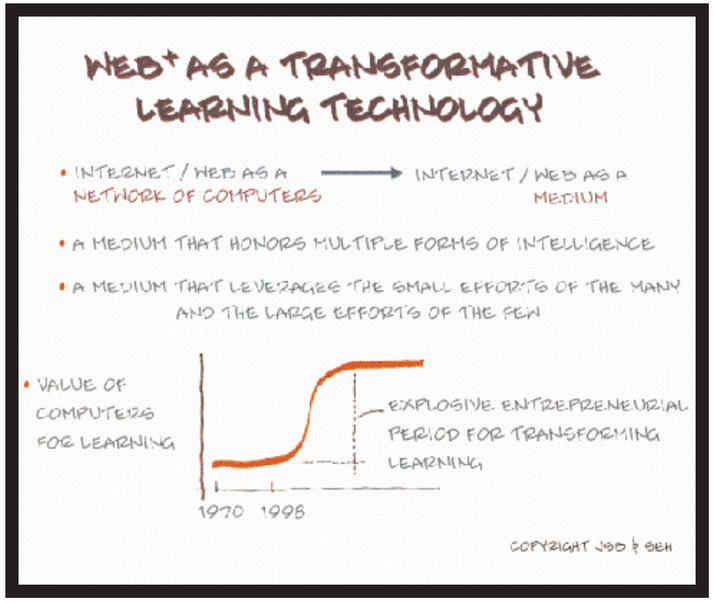
Growing Up Digital

How the Web Changes Work, Education, and the Ways People Learn

By John Seely Brown

In 1831 Michael Faraday built a small generator that produced electricity, but a generation passed before an industrial version was built, then another 25 years before all the necessary accoutrements for electrification came into place—power companies, neighborhood wiring, appliances (like light bulbs) that required electricity, and so on. But when that infrastructure finally took hold, everything changed—homes, work places, transportation, entertainment, architecture, what we ate, even when we went to bed. Worldwide, electricity became a transformative medium for social practices.

John Seely Brown is the chief scientist of Xerox and director of its Palo Alto Research Center.



In quite the same way, the World Wide Web will be a transformative medium, as important as electricity. Here again we have a story of gradual development followed by an exploding impact. The Web's antecedents trace back to a U.S. Department of Defense project begun in the late 1960s, then to the innovations of Tim Berners-Lee and others at the Center for European Nuclear Research in the late 1980s, followed by rapid adoption in the mid- and late-1990s. Suddenly we had e-mail available, then a new way to look up information, then a remarkable way to do our shopping—but that's barely the start. The tremendous range of transformations wrought by electricity, so barely sensed by our grandparents a century ago, lie ahead of us through the Web.

No one fully knows what those transformations will be, but what we do know is that initial uses of new media have tended to mimic what came before: early photography imitated painting, the first movies the stage, etc. It took 10 to 20 years for filmmakers to discover the inherent capabilities of their new medium. They were to develop techniques now commonplace in movies, such as "fades," "dissolves," "flashbacks," "time and space folds," and "special effects," all radically different from what had been possible in the theater. So it will be for the Web. What we initially saw as an intriguing network of computers is now evolving its own genres from a mix of technological possibilities and social and market needs.

Challenging as it is, this article will try to look ahead to understand the Web's fundamental properties; see how they might create a new kind of information fabric in which learning, working, and playing co-mingle; examine the notion of distributed intelligence; ask how one might better capture and leverage naturally occurring knowledge assets; and finally get to our core topic—how all of this might fold together into a new concept of "learning ecology." Along the way, too, we'll look frequently at learning itself and ask not only how it occurs now, but how it can become ubiquitous in the future.

A New Medium

The first thing to notice is that the media we're all familiar with—from books to television—are one-way propositions: they push their content *at* us. The Web is two-way, push *and* pull. In finer point, it combines the one-way reach of broadcast with the two-way reciprocity of a mid-cast. Indeed, its user can at once be a receiver and sender of "broadcast"—a confusing property, but mind-stretching!

A second aspect of the Web is that it is the first medium that honors the notion of multiple intelligences. This past century's concept of "literacy" grew out of our intense belief in text, a focus enhanced by the power of one particular technology—the typewriter. It became a great tool for writers but a terrible one for other creative activities such as sketching, painting, notating music, or even mathematics. The typewriter prized one particular kind of intelligence, but with the Web, we suddenly have a medium that honors multiple forms of intelligence—abstract, textual, visual, musical, social, and kinesthetic. As educators, we now have a chance to construct a medium that enables all young people to become engaged in their ideal way of learning. The Web affords the match we need between a medium and how a particular person learns.

A third and unusual aspect of the Web is that it leverages the small efforts of the many with the large efforts of the few. For example, researchers in the Maricopa County Community College system in Phoenix have found a way to link a set of senior citizens with pupils in the Longview Elementary School, as helper-mentors. It's wonderful to see—kids listen to these "grandparents" better than they do to their own parents, the mentoring really helps their teachers, and the seniors create a sense of meaning for themselves. Thus, the small efforts of the many—the seniors—complement the large efforts of the few—the teachers.

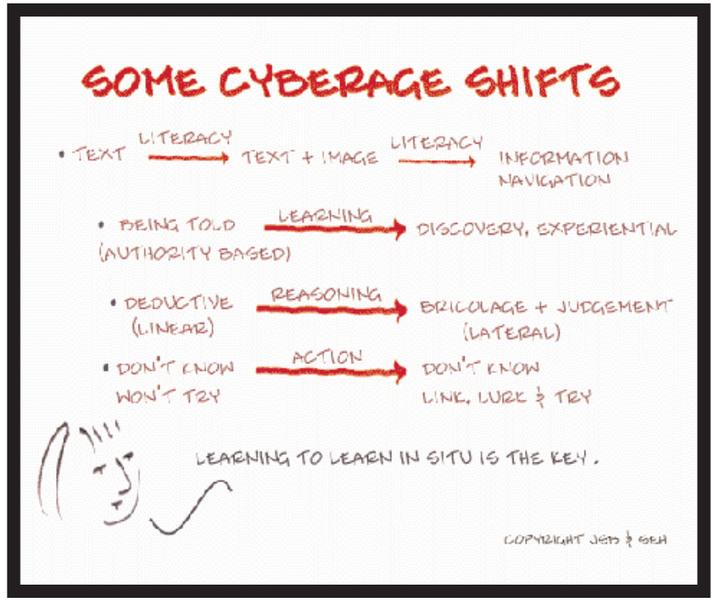
The same thing can be found in operation at Hewlett-Packard, where engineers use the Web to help kids with science or math problems. Both of these examples barely scratch the surface as we think about what's possible when we start interlacing resources with needs across a whole region.

The Web has just begun to have an impact on our lives. As fascinated as we are with it today, we're still seeing it in its early forms. We've yet to see the full-motion video and audio possibilities that await the bandwidth we'll soon have through cable modems and DSL; also to come are the new Web appliances, such as the portable Web in a phone, and a host of wireless technologies. As important as any of these is the imagination, competitive drive, and capital behind a thousand companies—chased by a swelling list of dot-coms—rushing to bring new content, services, and "solutions" to offices and homes.

My belief is that not only will the Web be as fundamental to society as electrification, but that it will be subject to many of the same diffusion and absorption dynamics as that earlier medium. We're just at the bottom of the S-curve of this innovation, a curve that will have about the same shape as with electrification, but a much steeper slope than before. As this S-curve takes off, it creates huge opportunities for entrepreneurs. It will be entrepreneurs, corporate or academic, who will drive this chaotic, transformative phenomenon, who will see things differently, challenge background assumptions, and bring new possibilities into being. Our challenge and opportunity, then, is to foster an entrepreneurial spirit toward creating new *learning* environments—a spirit that will use the unique capabilities of the Web to leverage the natural ways that humans learn.

Digital Learners

Let's turn to today's youth, growing up digital. How are they different? This subject matters, because our young boys and girls are today's customers for schools and colleges and tomorrow's for lifelong learning. Approximately four years ago, we at Xerox's Palo Alto Research Center started hiring 15 year olds to join us as researchers. We gave them two jobs. First, they were to design the "workscape" of the future—one they'd want to work in; second, they were to design the school or "learningscape" of the future—again, with the same condition. We had an excellent opportunity to watch these adolescents, and what we saw—the ways they think, the designs they came up with—really shook us up.

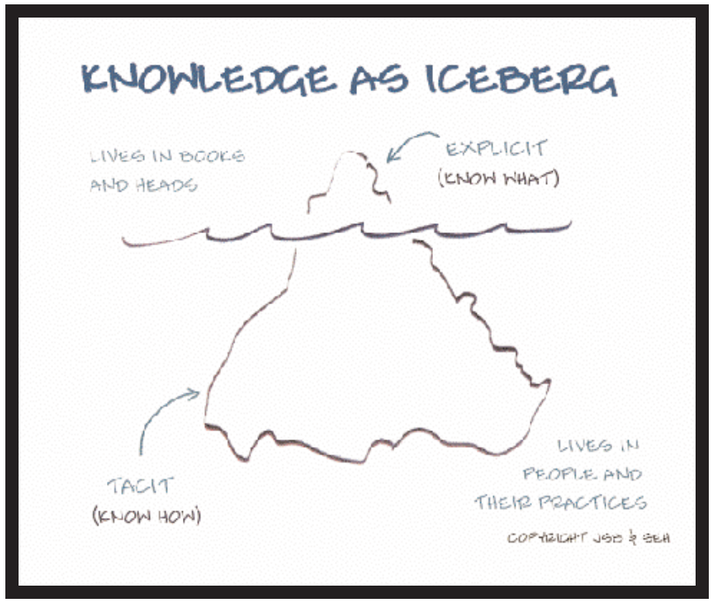


For example, today's kids are always "multiprocessing"— they do several things simultaneously—listen to music, talk on the cell phone, and use the computer, all at the same time. Recently I was with a young twenty-something who had actually wired a Web browser into his eyeglasses. As he talked with me, he had his left hand in his pocket to cord in keystrokes to bring up my Web page and read about me, all the while carrying on with his part of the conversation! I was astonished that he could do all this in parallel and so unobtrusively.

People my age tend to think that kids who are multiprocessing can't be concentrating. That may not be true. Indeed, one of the things we noticed is that the attention span of the teens at PARC—often between 30 seconds and five minutes—parallels that of top managers, who operate in a world of fast context-switching. So the short attention spans of today's kids may turn out to be far from dysfunctional for future work worlds.

Let me bring together our findings by presenting a set of dimensions, and shifts along them, that describe kids in the digital age. We present these dimensions in turn, but they actually fold in on each other, creating a complex of intertwined cognitive skills.

The first dimensional shift has to do with literacy and how it is evolving. Literacy today involves not only text, but also image and screen literacy. The ability to "read" multimedia texts and to feel com-



fortable with new, multiple-media genres is decidedly nontrivial. We've long downplayed this ability; we tend to think that watching a movie, for example, requires no particular skill. If, however, you'd been left out of society for 10 years and then came back and saw a movie, you'd find it a very confusing, even jarring, experience. The network news shows—even the front page of your daily newspaper—are all very different from 10 years ago. Yet Web genres change in *a period of months*.

The new literacy, beyond text and image, is one of information navigation. The real literacy of tomorrow entails the ability to be your own personal reference librarian—to know how to navigate through confusing, complex information spaces and feel comfortable doing so. "Navigation" may well be the main form of literacy for the 21st century.

The next dimension, and shift, concerns learning. Most of us experienced formal learning in an authority-based, lecture-oriented school. Now, with incredible amounts of information available through the Web, we find a "new" kind of learning assuming pre-eminence—learning that's discovery based. We are constantly discovering new things as we browse through the emergent digital "libraries." Indeed, Web surfing fuses learning and entertainment, creating "infotainment."

But discovery-based learning, even when combined with our notion of navigation, is not so great a change, until we add a third, more subtle shift, one that pertains to forms of reasoning. Classically, reasoning has been concerned with the deductive and abstract. But our observation of kids working with digital media suggests *bricolage* to us more than abstract logic. *Bricolage*, a concept studied by Claude Lévi-Strauss more than a generation ago, relates to the concrete. It has to do with abilities to find something—an object, tool, document, a piece of code—and to use it to build something you deem important. *Judgment* is inherently critical to becoming an effective digital *bricoleur*.

How do we make good judgments? Socially, in terms of recommendations from people we trust? Cognitively, based on rational argumentation? On the reputation of a sponsoring institution? What's the mixture of ways and warrants that you end up using to decide and act? With the Web, the sheer scope and variety of resources befuddles the non-digital adult. But Web-smart kids learn to become *bricoleurs*.

The final dimension has to do with a bias toward action. It's interesting to watch how new systems get absorbed by society; with the Web, this absorption, or learning process, by young people has been quite different from the process in times past. My generation tends not to want to try things unless or until we already know how to use them. If we don't know how to use some appliance or software, our instinct is to reach for a manual or take a course or call up an expert. Believe me, hand a manual or suggest a course to 15 year olds and they think you are a dinosaur. They want to turn the thing on, get in there, muck around, and see what works. Today's kids get on the Web and link, lurk, and watch how other people are doing things, then try it themselves.

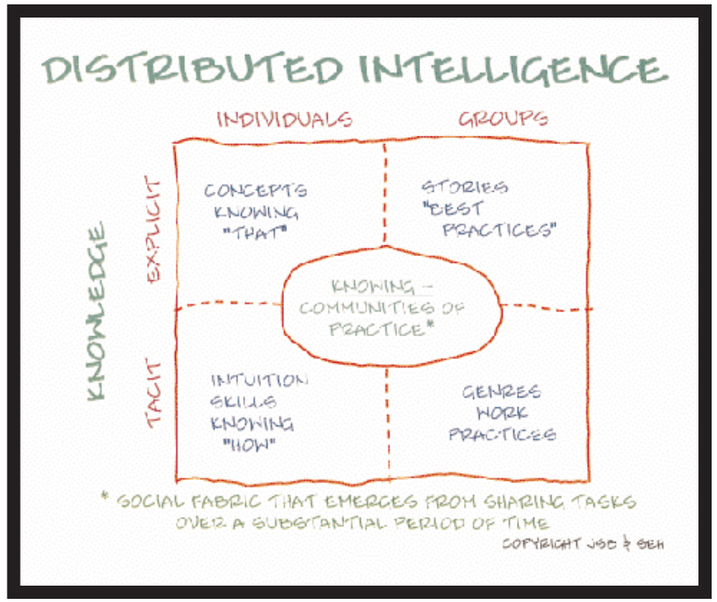
This tendency toward "action" brings us back into the same loop in which navigation, discovery, and judgment all come into play *in situ*. When, for example, have we lurked enough to try something ourselves? Once we fold action into the other dimensions, we necessarily shift our focus toward learning *in situ* with and from each other. Learning becomes situated in action; it becomes as much social as cognitive, it is concrete rather than abstract, and it becomes intertwined with judgment and exploration. As such, the Web becomes not only an informational and social resource but a *learning medium* where understandings are socially constructed and shared. In that medium, learning becomes a part of action and knowledge creation.

Creating Knowledge

To see how all these dimensions work, it's necessary to look at knowledge—its creation and sharing—from both the standard Cartesian position and that of the *bricoleur*. Knowledge has two dimensions, the explicit and tacit. The explicit dimension deals with concepts—the "know-*whats*"—whereas the tacit deals with "know-*how*," which is best manifested in work practices and skills. Since the tacit lives in action, it comes alive in and through doing things, in participation with each other in the world. As a consequence, tacit knowledge can be distributed among people as a shared understanding that emerges from working together, a point we will return to.

The developmental psychologist Jerome Bruner made a brilliant observation years ago when he said we can teach people *about* a subject matter like physics—its concepts, conceptual frameworks, its facts—and provide them with explicit knowledge of the field, but *being* a physicist involves a lot more than getting all the answers right at the end of each chapter. To be a physicist, we must also learn the practices of the field, the tacit knowledge in the community of physicists that has to do with things like what constitutes an "interesting" question, what proof may be "good enough" or even "elegant," the rich interplay between facts and theory-formation, and so on. Learning to be a physicist (as opposed to learning about physics) requires cutting a column down the middle of the diagram, looking at the deep interplay between the tacit and explicit. That's where deep expertise lies. Acquiring this expertise requires learning the explicit knowledge of a field, the practices of its community, and the interplay between the two. And learning all this requires immersion in a community of practice, enculturation in its ways of seeing, interpreting, and acting.

The epistemic landscape is more complicated yet because both the tacit and explicit dimensions of knowledge apply not only to the individual but also to the social mind—to what we've called communities of practice. It's common for us to think that all knowledge resides in individual heads, but when we factor in the tacit dimension—especially as it relates to practices—we quickly realize how much more we can know than is bounded by our own knowledge. Much of knowing is brought forth in action, through participation—in the world, with other people, around real problems. A lot of our know-how or knowing comes into being through participating in our community(ies) of practice.



Understanding how intelligence is distributed across a broader matrix becomes increasingly critical if we want to leverage "learning to learn," because learning to learn happens most naturally when you and a participant are situated in a community of practice. Returning to Bruner's notion of learning to be, recall that it always involves processes of enculturation. Enculturation lies at the heart of learning. It also lies at the heart of knowing. Knowing has as much to do with picking up the genres of a particular profession as it does with learning its facts and concepts.

Curiously, academics' values tend to put theory at the top in importance, with the grubbiness of practice at the bottom. But think about what you do when you get a PhD. The last two years of most doctoral programs are actually spent in close work with professors, *doing* the discipline with them; these years in effect become a cognitive apprenticeship. Note that this comes after formal course work, which imparted relevant facts and conceptual frameworks. Those frameworks act as scaffolding to help structure the practice developed through the apprenticeship. So learning *in situ* and cognitive apprenticeship fold together in this notion of distributed intelligence.

I dwell on this point because each of us has various techniques, mostly invisible, that we use day in and day out to learn with and from each other *in situ*. This is seen all the time on a campus, where students develop techniques for learning that span in-class and out-of-class experiences—all of campus life

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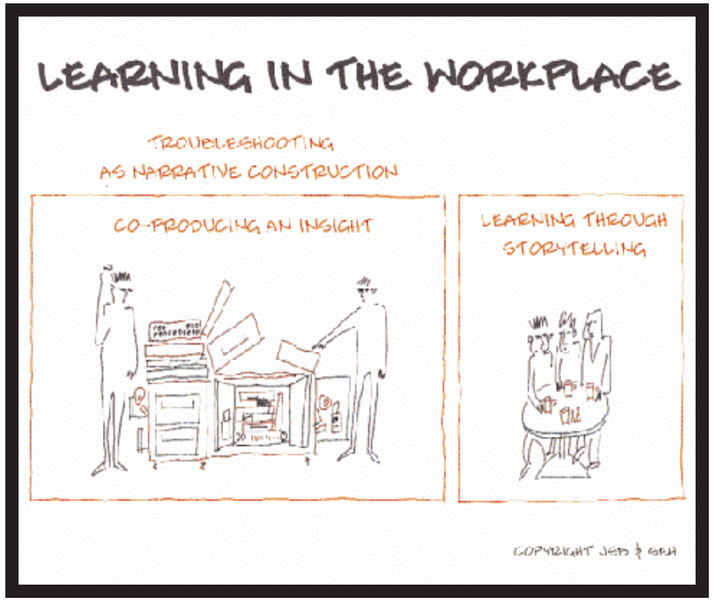

is about learning how to learn. Colleges should appreciate and support such learning; the key to doing so lies in understanding the dynamic flow in our two-by-two matrix.

If we could use the Web to support the dynamics across these quadrants, we could create a new fabric for learning, for learning to learn *in situ*, for that is the essence of lifelong learning.

Repairing Photocopiers

Talk about a "two-by-two conceptual framework of distributed intelligence" can be terribly abstract; let me bring this to life, and move our argument ahead, with a story from the company where I work. When I arrived at Xerox, back in the 1980s, the company was spending millions and millions of dollars a year training its 23,000 "tech reps" around the world—the people who repair its copiers and printers. Lots of that training—it was like classroom instruction—seemed to have little effect. Xerox wanted me to come up with some intelligent-tutoring or artificial-intelligence system for teaching these people troubleshooting. Fortunately, before we did so, we hired several anthropologists to go live in their "tribe" and see how they actually worked.

What the anthropologists learned surprised us. When a tech rep got stuck by a machine, he or she didn't look at the manual or review the training; he or she called another tech rep. As the two of them stood over the problematic machine, they'd recall earlier machines and fixes, then connect those stories to a new one that explained some of the symptoms. Some fragment of the initial story would remind them of another incident, which suggested a new measurement or tweak, which reminded them of another story fragment and fix to try, and so on. Troubleshooting for these people, then, really meant construction of a narrative, one that finally explained the symptoms and test data and got the machine up and running again. Abstract, logical reasoning wasn't the way they went about it; stories were.

This example demonstrates the crucial role of tacit knowledge (in the form of stories) within a community of practice (the tech reps). But the anthropologists had more to tell us. What happened to these stories? When the reps got back to the home office, awaiting the next call, they'd sit around and play cribbage, drink coffee, and swap war stories. Amazing amounts of learning were happening in the telling and hearing of these stories. In the telling, a story got refined, added to, argued about, and stored away for use.

Today, brain scientists have helped us understand more about the architecture of the mind and how it is particularly well suited to remembering stories. That's the happy part. The sad part is that some Xerox executives thought storytelling had to be a waste of time; big posters told the reps, "Don't tell war stories!" Instead, people were sent back for more training. When people returned from it, what did they do? Tell stories about the training, of course, in attempts to transform what they'd been told into something more useful.

Let me add here that these studies convinced us that for powerful learning to occur, you had to look to both the cognitive and the social dimensions. They also led us to ask, How can we leverage this naturally occurring learning?

Our answer to that question was simple: two-way radios. We gave everybody in our tech rep "community of practice" test site a radio that was always on, with their own private network. Because the radios were always on, the reps were constantly in each other's periphery. When somebody needed help, other tech reps would hear him struggling; when one of them had an idea, he or she could move from the periphery to the (auditory) center, usually to suggest some test or part to replace, adding his or her fragment to an evolving story. Basically, we created a multiperson storytelling process running across the test site. It worked incredibly well.

In fact, it also turned out to be a powerful way to bring new technicians into this community. A novice could lurk on the periphery and hear what was going on, learn from it, maybe ask a question, and eventually make a suggestion when he or she had something to contribute. In effect, the newcomer was a cognitive apprentice, moving from lurker to contributor, very much like today's digital kids on the Web.

The trouble with this scenario is that all these story fragments were being told through the ether, and hence were lost to those reps not participating at the moment. Some of these fragments were real gems! So we needed to find a way to collect, vet, refine, and post them on a community knowledge server. Furthermore, we realized that no one person was the expert; the real expertise resided in the community mind. If we could find a way to support and tap the collective minds of the reps, we'd have a whole new way to accelerate their learning and structure the community's knowledge assets in the making. We wanted to accomplish this, too, with virtually no overhead.

The answer for us was a new, Web-based system called Eureka, which we've had in use for two years now. The interesting thing is that the tech reps, in co-designing this system to make their ideas and stories more actionable, unwittingly reinvented the sociology of science. In reality, they knew many of the ideas and story fragments that floated around were not trustworthy; they were just opinions, sometimes crazy. To transform their opinions and experiences into "warranted" beliefs, hence actionable, contributors had to submit their ideas for peer review, a process facilitated by the Web. The peers would quickly vet and refine the story, and connect it to others. In addition, the author attaches his or her name to the resulting story or tip, thus creating both intellectual capital and social capital, the latter because tech reps who create really great stories become local heroes and hence more central members of their community of practice.

This system has changed the learning curve of our tech reps by 300 percent and will save Xerox about $100 million a year. It is also, for our purposes here, a beautiful example of how the Web enables us to capture and support the social mind and naturally occurring knowledge assets.

Building Knowledge Assets

What are some other emergent ideas—in the workplace or on campus—that might help us capture, refine, and share knowledge assets in the making? Are there ways to capture assets that are left just lying on the table, as it were, and use them to make learning more productive in classrooms, firms, even a region? The answer, now, is yes. Here are two examples, among many I've seen around the country, especially as entrepreneurs start to see this as ripe territory.

The first example I encountered was at Stanford University. It comes from Professor Jim Gibbons, the former dean of engineering. He discovered the basis of building knowledge assets accidentally some years ago and has been refining it since. Jim had been teaching an engineering course that enrolled several Hewlett-Packard people. Partway through the course, the H-P students were transferred and were no longer physically able to come to class. What Jim did was simply videotape the classes and send them the tapes.

The twist, though, is that once the engineers received the video they'd replay it in their own small study group, but in a special way. Every three minutes or so they'd stop the tape and talk about what they'd just seen, ask each other if there were any questions or ambiguities, and resolve them on the spot. Forward they would go, a few minutes at a time, with lots of talk and double-checking, until they were through the tape and everybody understood the whole lesson. What they were doing, in terms we used earlier, was socially constructing their own meaning of the material.

The results were that students taking the course this way outperformed the ones actually taking the classes live. Today, the approach has been tried with other H-P engineers, with college students, even with California prison

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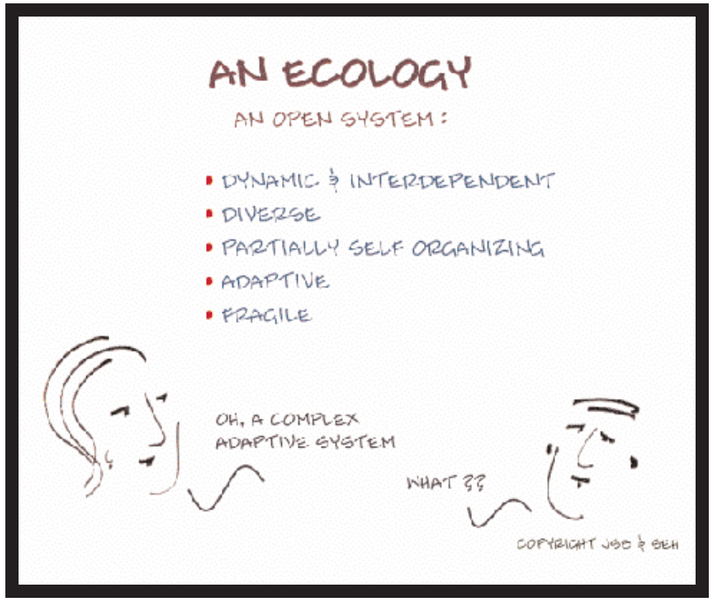
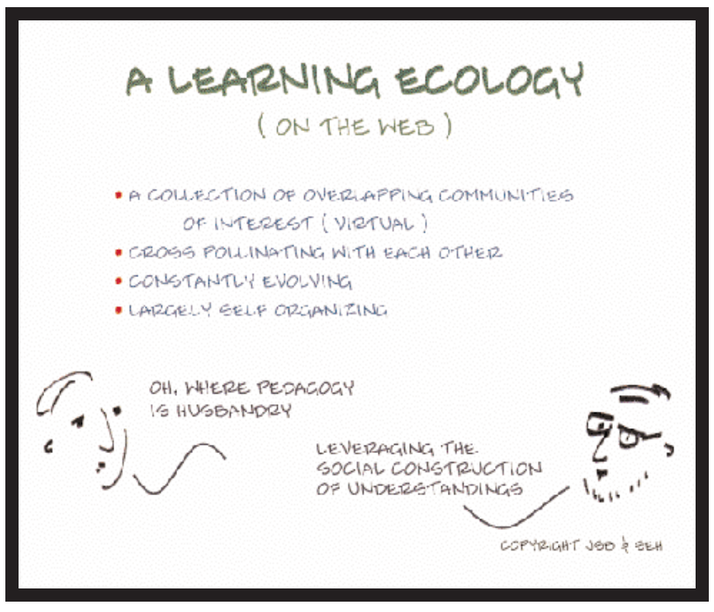




inmates; most of the students who've tried it got half a grade point better grades than the regular students. This account is not meant as a commentary on regular Stanford classes! Rather, it is used to describe an elegantly simple idea, low-tech and low-cost, about how forming study groups and letting them socially construct their own understanding around a naturally occurring knowledge asset—the lecture—turns out to be an amazingly powerful tool for learning. Think about what this suggests for distance learning—or for on-campus students.

The second example stems from research being done both at PARC and Cornell University. The PARC system is called Madcap and looks to see how we might leverage a knowledge asset, our weekly forums, where we often get some wonderful outside speakers. These forum events have proved a valuable stimulus to the whole Silicon Valley region. Of course we make videotapes and give them to people who miss a session. In reality, though, hardly anyone ever replays the tapes because it's very hard to skim through a video stream for the highlights you want. So we asked, Might it be possible to use computers to automatically segment and highlight a video stream? Perhaps even summarize it?

We now have a prototype system for doing this designed by Dan Russell's group at PARC. First we capture and store the digital video on a media server, which also marks and time-stamps any uniquely identifiable event such as clapping, laughing, a slide change, and so on. Audience members can also use their laptops or Palm Pilots to take notes; these can be time-stamped and thus cross-indexed into the video stream. We also transcribe the audio stream. All these "signals" are combined to make a soup of streams, all cross-indexed with each other. The resulting mixture becomes a very rich medium in which it's possible to skim and pick out highlights on your own. Or you can spot where a colleague made an annotation, see and hear the moment, then see what he or she thought about it.

This last point intrigues us: can you capture the additional signals generated by the audience—the notes, approvals, or disagreements recorded as the lecture progressed—and use these signals as structural indices to the video stream? The goal is to make this a richer knowledge asset than just the video alone, so that browsing, reflection, and focused conversations are more likely to happen. If you have a diverse set of individuals taking notes and they are willing to identify themselves, you start to create an ecology of annotations—diverse, overlapping, richly opinionated.

The goal, again, is to transform a lecture—a fleeting performance that only some people will experience—into a knowledge asset and tool for deeper learning among a greater number of people. At Cornell, Dan Hattenlocher's research team has added dual video cameras to the mix, one on the lecturer and one that zooms in on the student posing a question, to further enrich the segmenting and indexing of material on the tape. At PARC and Cornell alike, the aim of these tag structures is to transform the lecture into a more structured and useful knowledge asset. Of course this new asset, when viewed and vetted by subsequent audiences, becomes part of another knowledge performance (and knowledge sharing), leading to additional layers of cumulative annotation as its meaning gets further socially constructed.

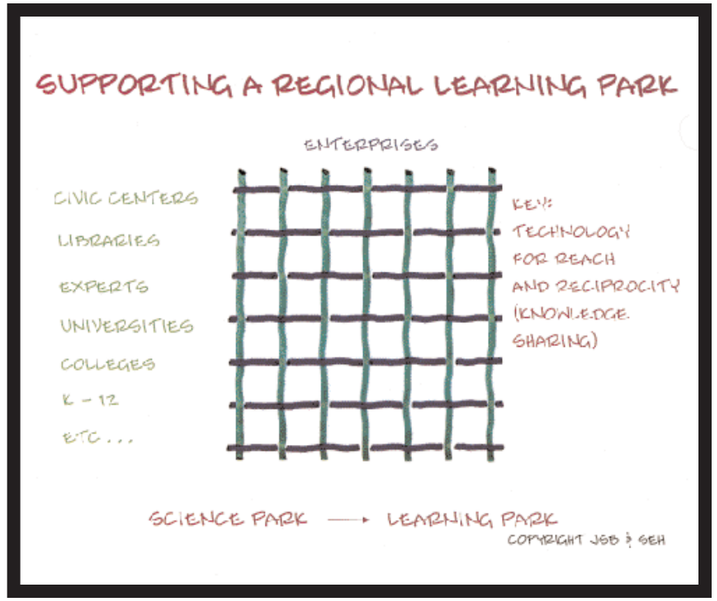
Toward a Learning Ecology

An ecology is basically an open, complex, adaptive system comprising elements that are dynamic and interdependent. One of the things that makes an ecology so powerful and adaptive to new environments is its diversity. Recall that with the prior examples of knowledge performances, it was the diversity of comments that gave texture to the knowledge asset and enabled it to be used in ways that might never have been originally imagined.

Let's consider a learning ecology, particularly one that might form around or on the Web. As a start down this path, consider the Web as comprising a vast number of "authors" who are members of various interest groups, many of which embody a lot of expertise in both written and tacit form. Given the vastness of the Web, it's easy these days to find a niche community with the expertise you need or a special interest group whose interests coincide exactly with your own.

Recall the famous *New Yorker* cartoon of a dog in front of a computer, saying, "On the 'Net nobody knows you are a dog." Online, a kid need not necessarily reveal himself as a kid. Indeed, I've watched a seven year old from New York have a conversation about penguins with an expert at a university in another state. The professor may have sensed that the person he was talking with wasn't a real expert on penguins, but he probably didn't know he was communicating with a second-grader, either. Furthermore, at this child's school there was no one, including his teachers, who shared his interest in penguins. He found the right interest group through navigation. He linked, he lurked, he finally asked a question, and had this brief conversation with an expert. And I can tell you, the professor's momentary effort truly inspired him.

With the Web, these virtual communities of niche interests spread around the world as they interweave with local, face-to-face groups, in school or outside. A new, powerful fabric for learning starts to emerge, drawing strength from the local and the global. A cross-pollination of ideas happens



as local students, participating in different virtual communities, carry ideas back and forth between those communities and their local ones.

Now recall our emphasis that informal learning often involves the joint construction of understanding around a focal point of interest, and one begins to sense how these cross-linked interest groups, both real and virtual, form a rich ecology for learning. Of course not all these conversations, even if focused and well intended, lead to productive learning. As we said earlier in discussing digital kids, judgment, navigation, discernment, and synthesis become more critical than ever.

Regional Learning

I've been struck, living in Silicon Valley and spending time in other high-tech regions, by how each region can be analyzed with respect to the quality and diversity of its knowledge producers and knowledge consumers.

The classic way to view knowledge production in a region is to list all the educational institutions one can think of—universities and colleges, schools, libraries, museums, civic centers—and to see these as the region's *producers* of knowledge, with the region's citizens, students, firms, government, and voluntary organizations as their *consumers*. The matrix on this page represents that relationship.

But in most regions I visit today, there is a rich interplay between the matrix's two axes, albeit one that seldom gets noticed. If

Resources

■ John Seely Brown's earlier work on "situated learning" came to notice in a series of widely cited journal articles:

■ Brown, J.S., A. Collins, and P. Duguid. "Situated Cognition and the Culture of Learning," *Educational Researcher*, Vol. 18, No. 1, 1989, pp. 32-42.

■ Brown, J.S. and P. Duguid, "Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation," *Organizational Science*, Vol. 2, No. 1, 1991, pp. 40-57.

■ Collins, A., J.S. Brown, and A. Holum, "Cognitive Apprenticeship: Making Thinking Visible," *American Educator*, Vol. 15, No. 3, 1991, pp. 6-11, 38-46.

■ In 1993, these ideas were pulled together and critiqued in a special issue of *Educational Technology* 33, Vol. 3, which includes a further Brown-Duguid contribution on "Stolen Knowledge" (pp. 10-15).

■ In 1996, Brown and Duguid's ideas about learning formed a centerpiece of their initial contribution to *Change*, "Universities in the Digital Age" (Vol. 28, No. 4, 1996, pp. 10-19), which came to be one of the magazine's most widely read and cited pieces.

■ Many ideas from that and their current *Change* article appear in Brown and Duguid's splendid new book, *The Social Life of Information* (Cambridge: Harvard Business School Press, 2000).

Editor's Note:

In 1987, Brown helped found the Institute for Research on Learning (IRL), located in Menlo Park, California, a "research-in-action" think tank that probes "successful everyday learning." Brown and Duguid acknowledge their debt to IRL colleagues for insight and critique that found its way into this article, and particularly to Susan Stucky and Peter Henschel for their two-by-two "distributed intelligence" chart on page 15.

the region is geographically compressed enough, you start to get all kinds of informal, face-to-face connections between knowledge producers and consumers—students work part-time in surrounding firms, new firms spin out of universities, employees are retrained on campus, different people frequent common hang-outs, and so on and on. In the 1970s and 1980s we were preoccupied with science parks; in the 1990s, all these connections produce what I think of as learning parks. Such learning parks bring increasingly rich intellectual and educational opportunities to their region. If top-quality schools and universities once primed the pump for science parks, we now see learning parks pushing resources the other way. In the relation between leading-edge firms and universities, for example, the firms increasingly provide adjunct professors, guest lectures, thesis supervision, internships for students, sabbaticals for faculty, and workplace experiences for scholars of all ages. So the traditional producers of knowledge (the faculty) are also becoming consumers of the knowledge that their traditional consumers (graduate students, firms in the region) produce. This is very healthy, indeed.

Now let's overlay on top of this physical-social region the Web, and look back to the example of students participating in local, face-to-face groups but tying also into virtual ones. A key understanding is that on the Web there seldom is such a thing as just a producer or just a consumer; on the Web, each of us is part consumer and part producer. We read and we write, we absorb and we critique, we listen and we tell stories, we help and we seek help. This is life on the Web. The boundaries between consuming and producing are fluid, which is the secret to many of the business models of Web-based commerce.

From a region's standpoint, the great opportunity here is that the Web helps establish a culture that honors the fluid boundaries between the production and consumption of knowledge. It recognizes that knowledge can be produced wherever serious problems are being attacked and followed to their root. Furthermore, with the Web it is easier for various experts to interact casually—in the academy or in the firm—and to mentor or advise students of any age. On top of this, the Web's great reach provides infinite access to resources beyond the region. The power of this reach comes fully into play when Web resources act to cross-pollinate and provide new points of view for a region's communities of practice.

Within a region, the Web can significantly augment the knowledge dynamics created by proximity. The Web helps build a rich fabric that combines the small efforts of the many with the large efforts of the few. By enriching the diversity of available information and expertise, it enables the culture and sensibilities of a region to evolve. It increases the intellectual density of cross-linkages. It allows anyone to lurk and learn. Indeed its message is that learning can and should be happening everywhere—a learning ecology. All together, a new, self-catalytic system starts to emerge, reinforcing and extending the core competencies of a region.

Let me end with a brief reflection on an interesting shift that I believe is happening: a shift between using technology to support the individual to using technology to support relationships between individuals. With that shift, we will discover new tools and social protocols for helping us help each other, which is the very essence of social learning. It is also the essence of lifelong learning—a form of learning that learning ecologies could dramatically facilitate. And developing learning ecologies in a region is a first, important step toward a more general culture of learning.