Lifelong Learning: Changing Mindsets

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Abstract

Lifelong learning is an essential challenge for inventing the future of our societies; it is a necessity rather than a possibility or a luxury to be considered. Lifelong learning is more than adult education or training — it is a mindset and a habit for people to acquire. It creates the challenge to understand, explore, and support new essential dimensions of learning such as: (1) self-directed learning, (2) learning on demand, (3) informal learning, and (4) collaborative and organizational learning.

Lifelong learning requires a deeper understanding of the co-evolutionary processes between fundamental human activities and their relationships and interdependencies with new media. It requires progress and an integration of new theories, innovative systems, practices, and assessment. To make lifelong learning an important part of human life, new intellectual spaces, physical spaces, organizational forms, and reward structures need to be created that allow individuals, groups, and organizations to personally engage in and experience these new forms as risk takers who use their creativity and imagination to explore alternative ways of learning.

Introduction

Learning needs to be examined across the lifespan because previous notions of a divided lifetime—education followed by work—are no longer tenable [Gardner, 1991]. Professional activity has become so knowledge-intensive and fluid in content that learning has become an integral and irremovable part of work activities. Learning is a new form of labor [Zuboff, 1988], and working is often (and needs to be) a collaborative effort among colleagues and peers. In the emerging information society, an educated person will be someone who is willing to consider learning as a lifelong process. More and more knowledge, especially advanced knowledge, is acquired well past the age of formal schooling, and in many situations through educational processes that do not center on the traditional school [Illich, 1971]. Lifelong learning as pursued in our research and as discussed in this article is more than adult education that is often restricted to providing people with opportunities to engage in (school-like) learning activities during their adult life. The objective of lifelong learning is to fundamentally rethink learning, teaching, and education for the information age in attempting to change mindsets. It involves and engages learners of all ages in acquiring and applying knowledge and skills in the context of authentic, self-directed problems, and it exploits the possibilities offered by new media.

Problems in the Information Age

Lack of creativity and innovation. Societies and countries of the future will be successful not "because their people work harder, but because they work smarter." Creativity and innovation are considered essential capabilities for working smarter in knowledge societies [Drucker, 1994]; thus an important challenge is how these capabilities can be learned and practiced. An implicit assumption made is that self-directed and lifelong learning can influence the creativity and innovation potential of individuals, groups, organizations, and countries [Dohmen, 1999].

Coping with change. Most people see schooling as a period of their lives that prepares them for work in a profession or for a change of career. This view has not enabled people to cope well with the following situations:

- most people change careers several times in their lives, even though what they learned in school was designed to prepare them for their first career;

- the pace of change is so fast that technologies and skills to use them become obsolete within 5-10 years;

- university graduates are not well prepared for work;

- companies have trouble institutionalizing what has been learned (e.g., in the form of organizational memories) to ensure that the departure of particular employees does not disable the companies' capabilities; and

- although employers and workers alike realize that they must learn new things, they often don't feel they have the time to do so.

School-to-work transition is insufficiently supported. If the world of working and living relies on collaboration, creativity, and framing of problems; deals with uncertainty, change, and distributed cognition; and augments and empowers humans with powerful technological tools, then the world of schools and universities needs to prepare students to function in this world. Industrial-age models of education and work (based on B.F. Skinner and F.W. Taylor; see Table 1) are inadequate to prepare students to compete in the knowledge-based workplace. A major objective of a lifelong learning approach is to reduce the gap between school and workplace learning [U.S. Congress, 1995] by exploring answers to questions such as:

- What "basic skills" are required in a world in which occupational knowledge and skills become obsolete in years rather than decades?

- How can schools (which currently rely on closed-book exams, the solving of given problems, and so forth) be changed so that learners are prepared to function in environments requiring collaboration, creativity, problem framing, and distributed cognition?

The "Gift Wrapping" approach dominates educational reform. Information technologies have been used to mechanize old ways of doing business [Landauer, 1995] — rather than fundamentally rethinking the underlying work processes and promoting new ways to create artifacts and knowledge. In learning, these technologies have been used primarily as add-ons to existing practices [Fischer, 1998b] rather than a catalyst for fundamentally rethinking what education should be about in the next century. Frameworks, such as instructionism, fixed curricula, memorization, decontextualized rote learning, etc., are not changed by technology itself. We cannot prepare people to live in a twenty-first century world using nineteenth century technology. "Computer literacy" has often been equated with a bag of superficial and transitory knowledge rather than with what really matters about computers: namely, that we can use them for our own purposes [Illich, 1973] by becoming independent of high-tech scribes [Fischer, 1994b]. New technologies and new media (such as the World Wide Web, multi-media design, etc.) are necessary to achieve certain learning objectives and to provide foundations for people to change their mindsets, but they by themselves are not sufficient. Just as "the music is not the piano" [Kay, 1996], the fundamental challenges for computers and education are not a function of the technologies themselves, but of the social arrangements we create around their uses.

Changing Mindsets

Cultures are substantially defined by their media and their tools for thinking, working, learning, and collaborating. A large number of new media are designed to see humans only as consumers. Television is the most obvious medium that promotes this mindset and behavior [Postman, 1985]. Unfortunately, a consumer mindset does not remain limited to television, but in many cases is a model dominating our culture. In our educational institutions, learners are often treated as consumers, creating a mindset of consumerism for the rest of their lives. Citizens often feel left out in the decisions by policy makers, denying them opportunities to take an active role.

The current mindset about learning, teaching, and education is dominated by a view in which teaching is often fitted "into a mold in which a single, presumably omniscient teacher explicitly tells or shows presumably unknowing learners something they presumably know nothing about" [Bruner, 1996]. A critical challenge is a reformulation and reconceptualization of this

impoverished and misleading conception. Although this model may be more realistic for the early grades in schools, it is obviously inadequate for learning processes as they occur in lifelong learning, where knowledge is distributed among many stakeholders and "the answer" does not exist or is not known. Learning is more than being taught [Illich, 1971]. Learning new skills and acquiring new knowledge cannot be restricted to formal educational settings. By *integrating working and learning* [Sachs, 1995], people learn within the context of their work on real-world problems. Learning does not take place in a separate phase and in a separate place, but is integrated into the work process. People construct solutions to their own problems, and the system advises them when they are getting into trouble and provides directly relevant information. The direct usefulness of new knowledge for actual problem situations greatly improves the motivation to learn the new material because the time and effort invested in learning are immediately worthwhile for the task at hand — not merely for some putative long-term gain.

Many conventional educational (programmed instruction, computer-based training) and working (the assumption there exists a best scientific way) frameworks are grounded in the behaviorist learning theory of Skinner and the models of industrial work of Taylor. Table 1 contrasts these approaches with postulating new goals and new objectives for the information age.

Skinner/Taylor		Beyond Skinner and Taylor
there is a "scientific," best way to learn and to work	--->	real problems are ill-defined and wicked
separation of thinking, doing, and learning	--->	integration of thinking, doing, and learning
task domains can be completely understood	--->	understanding is partial; coverage is impossible
objective ways to decompose problems into standardizable actions	--->	subjective, situated personal interests; need for iterative explorations
all relevant knowledge can be explicitly articulated	--->	much knowledge is tacit and relies on tacit skills
teacher / manager as oracle	--->	teacher / manager as facilitator or coach
operational environment: mass markets, simple products and processes, slow change, certainty	--->	customer orientation, complex products and processes, rapid and substantial change, uncertainty and conflicts

Table 1: Transcending Skinner and Taylor

The conceptual framework outline in Table 1 provides the foundation to characterize a differentiation between school and lifelong learning, as illustrated by Table 2. Assuming that schools create mindsets about learning, teaching, and collaboration implies that there is no evidence that a *"big switch" theory* will succeed, meaning that a student who was educated as a passive consumer will suddenly switch to an active contributor.

	School/University	Lifelong Learning
emphasis	"basic" skills; exposure; access	education embedded in ongoing work activities; informed participation
potential drawbacks	decontextualized, not situated	important concepts are not encountered
problems	given	constructed
new topics	defined by curricula	arise incidentally from work situations
structure	pedagogic or "logical" structure	work activity
roles	expert-novice model	reciprocal learning; "symmetry of ignorance"
teachers / coaches	expound subject matter	engage in work practice
mode	instructionism (knowledge absorption)	constructionism (knowledge construction)

Table 2: Comparison of Different Conceptualizations of School/University and Lifelong Learning

To create different mindsets, we need to change our formal educational institutions to environments where knowledge is externalized and shared and not just something in students' minds, and where its production is a collective, collaborative effort. Knowledge should not be presented by teachers (who see themselves as all-knowing truth-tellers and oracles) as a commodity to be acquired, but as a human struggle to understand, to overcome falsity, and to stumble towards the truth. Skills and processes that support learning as a lifetime habit must be developed, and every effort must be undertaken for learners to develop a positive attitude and enjoyment toward learning — because no one will engage in processes and attitudes in their whole life for goals and objectives that they do not like.

Emphasizing New Forms of Learning from a Lifelong Learning Perspective

Lifelong learning does not refer to a completely educationally managed society, and it does not imply that learning is an externally imposed requirement, but it refers to a society in which learning possibilities exist for those who want to learn.

Self-Directed Learning. Most learning taking place outside of an (instructionist) classroom can be characterized as follows: humans are engaged in some activity (some action such as working, collaboratively solving a problem, or playing), they experience a breakdown and they reflect about the breakdown (i.e., the piece of lacking knowledge, the misunderstanding about the consequences of some of their assumptions, etc.). Engagement in and support for self-directed learning [Fischer, 1999a] are critical when learning becomes an integral part of life — driven by our desire and needs to understand something, or to get something done instead of solving a problem given in a classroom setting. A lifelong learning perspective implies that schools and universities need to prepare learners to engage in self-directed learning processes because this is what they will have to do in their professional and private lives outside of the classroom. It is advantageous for both motivation and the ability to acquire new knowledge that students be able to direct their own learning. Self-directed learning de-emphasizes teaching as a process in which a teacher tells something to a passive learner, but focuses instead on mutual dialogs and joint knowledge construction enhanced by the creation, discussion and evolution of artifacts. It is an attempt to transform learning (1) from something that is externally prescribed and ordained to something that is directed by learners themselves, and (2) from something whose coherence is derived from systematic branches of science to something whose contexts are developed by learners from their own questions, problems, and interests.

Learning on Demand. If the hypothesis that most job-relevant knowledge must be learned on demand [Fischer, 1991] is true, we have to ask ourselves: What is the role of "basic skills"? If, for example, the use of software packages dominates the use of mathematics in the workplace, shouldn't a new function of mathematics education be teaching students to use these mathematical artifacts intelligently? Another important challenge is that the "old basic skills" such as reading, writing, and arithmetic, once acquired, were relevant for the duration of a human life; modern "basic skills" (tied to rapidly changing technologies) will change over time.

Informal Learning. Learning in the information age cannot be restricted to learning within formal educational institutions; it is moving out of schools into the home, the community, and the workplace: it is a general life function. Informal learning [Norman, 1993] has a number of desirable attributes missing from formal learning such as: it is often done as a group or joint activity rather than an individual activity; the goal is motivated from the learner's point of view and the activity is considered fun; the person has a choice of topic, time and place; and the activities can be done throughout life in many environments. Schools and universities of the future should value informal learning activities and create new social, physical and computational environments in which informal learning can flourish.

Collaborative and Organizational Learning. Based on the fact that the individual human mind is limited (there is only so much we can learn during a lifetime), lifelong learning is often embedded and requires exploiting the social nature of human understanding and practices [Fischer, 1999b]. Collaborative and organizational learning [Koschmann, 1996; Senge, 1990] are grounded in the social nature of thinking; recognizing that how people think and learn is deeply influenced by the communities and cultures with which they interact. Despite these widely shared insights, education and pedagogy still primarily concentrate on the individual and individual performance; even most work is highly collaborative and social. The mindset of students is often formed that collaborative efforts are regarded as cheating in a competitive environment.

Organizational learning focuses on recording knowledge gained through experience (in the short term), and actively making that knowledge available to others when it is relevant to their particular task (in the long term). A central component of organizational learning is a repository for storing knowledge in an organizational memory. Individual projects serve organizational memory by adding new knowledge that is produced in the course of doing design work, such as artifacts, design rationale, and critiquing knowledge. For sustained organizational learning, three seemingly disparate goals must be served simultaneously. Organizational memory must be (1) extended and updated as it is used to support work practices, (2) continually reorganized to integrate new information and new concerns, and (3) serve work by making stored information relevant to the new task at hand.

Form	Complementing Form	Contribution toward Mindset Creation	Major Challenges	Media Requirements
self-directed learning	prescribed learning	authentic problems	problem framing	understanding evolving tasks
learning on demand	learning in advance	coverage is impossible; obsolescence is guaranteed	identifying the breakdown leading to the demand; integration of working and learning	critics; supporting reflection-in-action
informal learning	formal learning	learning by being in the world	larger, purposive activities provide learning opportunities	end-user modifiability
collaborative and organizational learning	individual learning	the individual human mind is limited	shared understanding; exploiting the "symmetry of ignorance" as a source of power	externalizations understandable by all stakeholders

Table 3: Overview of New Forms of Learning Contributing to Lifelong Learning

Summary. Table 3 summarizes the four approaches briefly discussed, their contributions toward the creation of mindsets, the major challenges of lifelong learning addressed by them, and the media requirements generated by them.

The Impact of Lifelong Learning Themes on Mindsets

Impacting mindsets is a socio-technical design problem. Research and practice in this area should not be restricted to analyzing and understanding how learning and thinking in fact do work, but it should be conducted as an instrument of change to alter and improve the way people learn and think. Creating innovative media and technologies supporting a "new" mindset requires the following co-evolution: we must rethink and reinvent learning, working, collaboration, and education in the context of new media, and simultaneously we must invent and create new media in the context of learning, working, collaboration, and education. Some themes illustrating this challenge are briefly described here.

From Consumer to Designers

To create designer mindsets, one of the major roles for new media and new technologies is not to deliver predigested information to individuals, but to provide the opportunity and resources for social debate, discussion, and collaborative knowledge construction. In many design activities, learning cannot be restricted to finding knowledge that is "out there". If nobody knows the answer, we have to create new knowledge. For most design problems (ranging from urban design to graphics design and software design) that we have studied over many years, the knowledge to understand, frame, and solve them does not exist, but is constructed and evolved during the process of solving these problems, exploiting the power of the "symmetry of ignorance" [Rittel, 1984] and "breakdowns" [Schön, 1983]. From this perspective, *access* to existing information and knowledge (often seen as the major advance of new media) is a very limiting concept [PCAST, 1997]. Many social and technological innovations are limited to provide primarily better access, leading to "consumer" cultures [Fischer, 1998a]. Our research focuses on and creates support for lifelong learning activities grounded in informed participation [Brown et al., 1994] and empowerment, allowing learners to incrementally acquire ownership in problems and contributing actively to their solution. Rather than serving as the "reproductive organ of a consumer society" [Illich, 1971], educational institutions must cultivate the development of a "designer mindset" by creating habits and tools that help people become empowered and willing to actively contribute to the design of their lives and communities. This goal creates the challenge to develop open, evolvable systems, allowing end-users themselves to extend their tools and information spaces, thereby becoming independent of professionals.

Domain-Oriented Design Environments

The most promising way to provide opportunities for a "designer mindset" is to allow learners and workers to engage in design activities by creating environments supporting them in making external artifacts that they can reflect upon and share with others. Design deals with ill-defined and open problems for which there are no ready-made, "correct," memorizable answers or "preset "curricula. Over the last ten years we have built a large number of different domain-oriented design environments (DODEs) [Fischer, 1994a] supporting the forms of learning described in the previous section. Figure 1 shows a screen image of one of our DODEs in the domain of kitchen design [Nakakoji, 1993].

DODEs support mechanisms such as the construction of artifacts in a specific domain, critiquing of these constructions, accessing catalogs of existing designs, linking to contextualized argumentation, and end-user modifiability. DODEs not only can be used to instruct and assist novice designers, but they are able to support designers as lifelong learners. They are built from appropriate substrates allowing the creation of complex, open, and evolvable systems. Agentsheets [Repenning, 1999] is an example of an existing substrate that can be used to develop educational interactive simulations. Agentsheets' visual programming approach allows a wide range of users to create these simulations in the context of self-directed learning, rather than being confined to a consumer role of dealing with what already exists.

DODEs support the mentioned learning forms as follows: they support

- self-directed learning by allowing users to work on their task within a particular domain (rather than making them work on a systems-defined task as most intelligent tutoring systems do);

- learning on demand by supporting learning from breakdowns; critics assist users in becoming aware of breakdowns and they activate task-relevant argumentation;

- informal learning by providing the vocabulary, tools, functions, and practices within the system that come from the working environment, where they are natural and appropriate;

- collaborative and organizational learning by supporting not only the individual's solo performance, but work in cooperation with others.
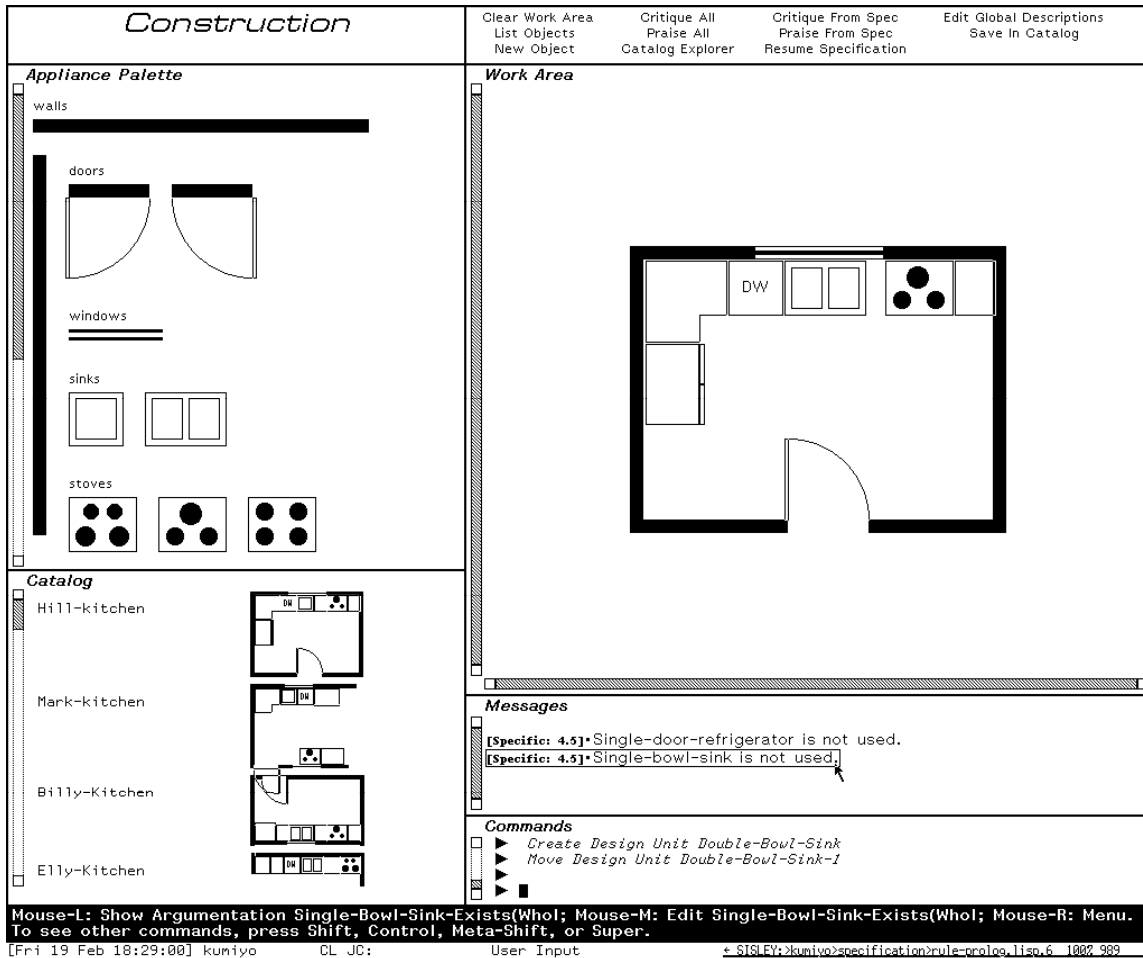
Figure 1: A DODE Supporting Kitchen Design

The Envisionment and Discovery Collaboratory: Transcending the Individual Human Mind

The Envisionment and Discovery Collaboratory (EDC) [Arias et al., 1997] is a conceptual framework not only to provide access to existing information, but to allow all participants to engage in *self-directed learning* by supporting informed participation and collaborative knowledge construction. The framework has been instantiated in a number of different domains (e.g., urban planning, design of new learning environments) to support activities and discourses where real questions are being investigated and participants are trying to contribute to progress on those questions. It is an environment that combines physical and computational simulations to allow collaborative and organizational learning by supporting group decision-making, mutual learning processes and the creation of shared understanding. The incremental design and construction of an externalized world provides numerous opportunities for all involved stakeholders for self-directed learning and learning on demand. The central theoretical vision of the EDC is to provide contextualized support for reflection-in-action [Schön, 1983] within collaborative design activities. Figure 2 shows the current realization of the EDC environment. Using the horizontal electronic whiteboard, participants work "around the table" creating incrementally a shared model of the problem. They interact with computer simulations in the action space by manipulating three-dimensional, physical objects, which constitute a language for the domain. The position and movement of these physical objects are recognized by means of the touch-sensitive projection surface. In the figure, participants are constructing a neighborhood through the use of a physical language appropriate for the problem by placing objects representing houses, cars, traffic lights, and so on. This construction then becomes the object through which the participants can collaboratively evaluate and prescribe changes in their efforts to frame and

resolve a problem. In the upper half of Figure 2 is a second electronic whiteboard that serves as the *reflection space*, where information related to the problem-at-hand can be presented, explored, and reframed.
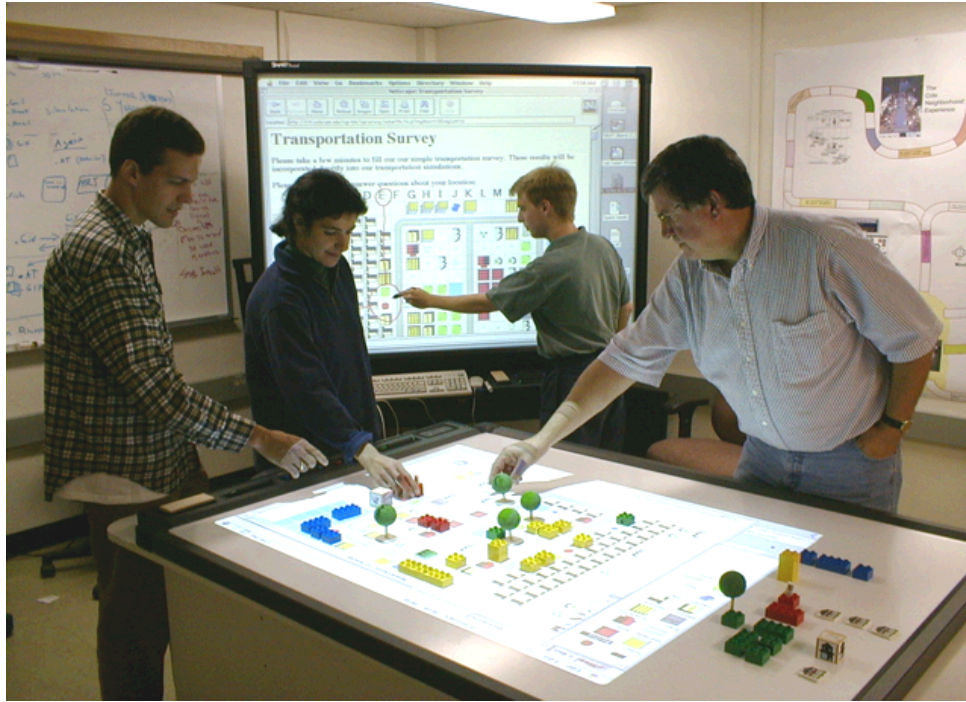

Figure 2: The EDC Environment

Beyond Classrooms: Environments for Lifelong Learning

As argued before, one of the most impoverished paradigms of education is a setting where a single, all-knowing teacher tells or shows presumably unknowing learners something they presumably know nothing about [Bruner, 1996]. Despite the fact that significant efforts are under way to change the nature of school discourse to make it more of a collective inquiry (see Table 2 and [Scardamalia & Bereiter, 1994]), this model of education is still widely practiced in our educational institutions and has led critics such as Illich [Illich, 1971] to claim that our schools and universities are the "reproductive organs of a consumer society" and "people who are hooked on teaching are conditioned to be customers for everything else." As an alternative, we should reconceive classrooms as places in which subcommunities of learners act simultaneously as learners, as designers and active contributors, and in which peer-to-peer learning is supported while the teacher acts as a "guide on the side" rather than as a "sage on the stage". In such settings, courses can be reconceptualized as seeds jointly evolved by all participants rather than finished products delivered by teachers [Fischer, 1997].

Based on the belief that the history of our practices speaks more truly than our slogans, we have tried to make the *self-application* of our conceptual frameworks and our systems to our own practice an important requirement. Our activities in and beyond the classroom at CU-Boulder are grounded in descriptive and prescriptive goals such as (documentation and discussions of these activities can be found at: http://www.cs.colorado.edu/~l3d/):

- self-directed learning should take place in the context of authentic, complex problems (because learners will refuse to quietly listen to someone else's answers to someone else's questions) and learning should be embedded in the pursuit of intrinsically rewarding activities;

- learning on demand needs to be supported because change is inevitable, complete coverage is impossible, and obsolescence is unavoidable;

- opportunities for informal learning are created by allowing students of all ages to participate in a rich set of activities;
- collaborative and organizational learning must be supported because the individual human mind is limited; and
- skills and processes that support learning as a lifetime habit must be developed.

We have incorporated a broad spectrum in innovative technologies in our courses, and we have carefully tracked and analyzed the challenges to existing mindsets beyond the introduction of new technologies. We have found that risk taking by faculty members is often not rewarded by the students. With current assessment instruments (such as faculty course questionnaires), it is also not rewarded by the institution, and as a result it is a potentially dangerous undertaking by (specifically for young, untenured) faculty members. While risk takers are urgently needed to explore the universities of the future, the forces of the established system and the potential pitfalls encountered lead many faculty members and students preferring to engage in business as usual. The risks are not restricted to faculty members: students participating in new courses often spend more time and energy on them than on traditional courses, and their confrontation with unfamiliar environments may cause fear and insecurity.

Risk taking is a consequence of different mindsets clashing with each other; this can be illustrated with one specific example: the "mismatch problem" between teachers and learners in teacher-driven/instructionist vs. self-directed/constructionist learning environments, as summarized in Table 4 [Grow, 1999]. The major mismatches that we have observed in our courses are that (1) dependent, passive learners take courses with non-directive teachers, or (2) self-directed, discovery-oriented active learners take courses with directive, authoritarian teachers.

Teacher	Student	Example
authority ("sage on the stage")	dependent, passive	lecture without questions
motivator and facilitator	interested	lecture with questions, guided discussion
delegator	involved	group projects, seminar
coach/critic ("guide on the side")	self-directed, discovery-oriented	self-directed study group, apprenticeship, dissertation

Table 4: Mismatches between Different Teacher and Learner Populations

Evaluation

Self-directed learning, learning on demand, informal learning, and collaborative and organizational learning are fundamentally different from the traditional classroom learning dominated by curricula and tests. Evaluation of these forms of learning is an important, unresolved research topic in itself; we cannot expect that there are off-the-shelf assessment techniques available for these new forms of learning. It requires alternative approaches to standard tests and the experimental methods of psychology which measure how people perform on predetermined tasks undertaken by subjects in a laboratory or in an instructionist classroom. Approaches from anthropology, sociology and ethnography that study people "in the wild", as they go about their everyday activities in offices, homes, schools, laboratories, or where ever they live their life [Nardi, 1997] are needed to evaluate these forms of learning. It is all to easy to collect data and statistics about those things that are easiest to identify and count or measure but which have little or no connection with the objectives we are really interested in. We have to develop evaluation techniques based on performance-based examinations, execution of large-scale projects, and maintenance and submission of a portfolio [Gardner, 1991]. It is obvious that a change of mindsets cannot be evaluated by a test; it requires assessment of motivation, interest level, and participation in communities of learners combined with techniques for long-term longitudinal assessment.

Conclusions

Peter Drucker argued that *"There is nothing so useless as doing efficiently that which should not be done at all."* Adding new media and new technologies to existing practices will not change the consumer mindsets of learners and workers. We need to explore new computational media based on fundamental aspects of how we think, create, work, learn, and collaborate. It simply is not good enough to spend money on new technologies and then to use it in old ways. New tools will not just help people do cognitive jobs more easily but in the same way they used to, but they will also lead to fundamental alterations in the way problems are solved. In a *designer culture* breakdowns will be seen as opportunities rather than as things to be avoided; teachers will understand their roles not only as truth-tellers and oracles, but as coaches, facilitators, and mentors; and knowledge will not be presented as a commodity to be acquired or delivered, but as a human struggle to understand and as a source to deal with personally meaningful problems. The future of how we live, think, create, work, learn, and collaborate is not out there to be "discovered"— it has to be *invented and designed*. Designer mindsets in the context of personally meaningful problems will be an integral part of the future.

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