Distance Learning —> Distributed Learning
Making the Transformation

The development of high-performance computing and communications is creating new media, such as the World Wide Web and virtual reality. In turn, these new media enable new types of messages and experiences; for example, interpersonal interactions in immersive, synthetic environments lead to the formation of virtual communities. The innovative kinds of pedagogy empowered by these emerging media, messages, and experiences make possible a transformation of conventional distance education—which replicates traditional classroom teaching across barriers of distance and time—into an alternative instructional paradigm: distributed learning.

New Media and Distance Education

What does the evolution of new media mean for distance educators? A medium is in part a channel for conveying content; new media such as the Internet allow us to readily reach wider, more diverse audiences. Just as important, however, is that a medium is a representational container enabling new types of messages (e.g., a picture is worth a thousand words). Because the process of thinking is based on representations like language and imagery, the process of learning is strongly shaped by the types of instructional messages we can exchange with students. Emerging representational containers like hypermedia enable a broader, more powerful repertoire of pedagogical strategies.

The global marketplace and the communications and entertainment industries are driving the rapid evolution of high-performance computing and communications. Regional, national, and global information infrastructures are being developed to enhance our abilities to sense, act, and learn across barriers of distance and time. The ways in which information is created, delivered, and used in business, government, and society are swiftly changing. To successfully prepare students as workers and citizens, educators must incorporate experiences creating and utilizing new forms of expression, such as multimedia, in the curriculum. Information infrastructures offer channels for delivering these technology-intensive learning experiences to any place on demand.

The information superhighway metaphor now widely used to convey the implications of high-performance computing and communications is inadequate. Such an analogy is the equivalent of someone in 1896 declaring that the airplane will be the canal system of the 20th century. Backward-looking metaphors focus on what we can automate—how we can use new channels to send conventional forms of content more efficiently—but they miss the true innovation: redefining how we communicate and educate by using new types of messages and experiences to be more effective. Because emerging forms of representation such as hypermedia and virtual reality are in their early stages of development, we are just beginning to understand how they shape not only their messages but also their users.

Many people are still reeling from the first impact of high-performance computing and communications—shifting from the challenge of not getting enough information to the challenge of surviving too much information. The core skill for today’s workplace is not foraging for data but filtering a plethora of incoming information. The emerging literacy we all must master requires diving into a sea of information and immersing ourselves in data in order to harvest patterns of knowledge, just as fish extract oxygen from water with their gills. As educators, understanding how to structure learning experiences to make such immersion possible is the core of the new rhetoric. Expanding traditional definitions of literacy and rhetoric into immersion-centered experiences of interacting with information is crucial to preparing students for full participation in 21st-century society.

Four New Models

Conventional distance education is similar to traditional classroom instruction except that it uses technology-based delivery systems. In contrast, emerging forms of distributed learning are leading to a reconceptualization of education’s mission, clients, process, and content. This new instructional paradigm is based on shifts in what learners need to be prepared for the future as well as on new capabilities in the pedagogical repertoire of teachers. The following four new forms of expression are shaping the emergence of distributed learning as a new pedagogical model.

- Knowledge webs complement teachers, texts, libraries, and archives as sources of information.
- Interactions in virtual communities complement face-to-face relationships in classrooms.
- Experiences in synthetic environments extend learning-by-doing in real-world settings.
- Sensory immersion helps learners grasp reality through illusion.

We are just beginning to understand how these representational containers can reshape the content, process, and delivery of conventional distance education. Information infrastructures are the lever for this evolution, just as the steam engine was the driver for the industrial revolution.

Knowledge Webs. Knowledge webs enable distributed access to experts, archival resources, authentic environments, and shared investigations. We are accustomed to asking a well-informed person in our immediate vicinity for guidance. We are accustomed to consulting printed information, watching a news program, visiting exhibits (such as a zoo or
Weaving learner-centered, constructivist usage of linked, online materials into the curriculum and culture of traditional educational institutions is the next stage of evolution for conventional distance education.

Virtual Communities. Virtual communities that provide support from people who share common joys and trials are a second way to enhance distributed learning. We are accustomed to face-to-face interaction as a way to get to know people, share ideas and experiences, enjoy "human" discourse, and find solace. In a different manner, distributed learning using information infrastructures can satisfy these needs at any time and any place. Some people (e.g., those who are shy, reflective, and comfortable with emotional distance) even find asynchronous, low-bandwidth communication more "authentic" than face-to-face verbal exchange. They can take time before replying to compose a more elegant message and refine the emotional nuances they wish to convey.

This alternative conception of authenticity may reflect a different dimension to learning styles than the visual, auditory, symbolic, and kinesthetic differentiations now used.

To dramatically improve learning outcomes by evolving new pedagogical strategies, distance educators need the information infrastructures that virtual communities make possible. Learning is social as well as intellectual. Individual, isolated attempts to make sense of complex data can easily fail unless the learner is encouraged by a larger group that is constructing shared knowledge. In addition, institutional evolution is a common enterprise; educational innovators need emotional and intellectual support from others who have similar challenges in their lives.

Moreover, formal education comprises only 15% of what students spend their time. No matter how well schooling is done, achieving major gains in learning requires that students make independent or collective contributions. Even when 20% of a triangle's internal angles is 180 degrees—this knowledge is often "inert," most people don't know how to apply the abstract principles they memorized in school to real-world problems. To move students from assimilating inert facts into generating mental models, teachers must structure learning experiences that highlight how new ideas can provide insights in intriguing and challenging situations.

The curriculum is already overcrowded with low-level information; teachers frantically race through required material, helping students memorize factual data to be regurgitated on mandated, standardized tests. Using information infrastructures as a fire hose to spray more information into educational settings would make this situation even worse. Without skillful facilitation, many learners who access current knowledge webs will flounder in a morass of unstructured data.

A vital, emerging form of literacy that educators must communicate to students is "how to learn." How do students transfer what they learn into non-school knowledge? How do new skills and capabilities enhance by groupware tools readily enable such student-student relationships, as well as preparing their participants for later use of distributed problem-solving techniques in the workplace. Telementoring and teleappraisals between students and adults are similar examples of applying virtual-community capabilities to distributed learning.

Creating a sense of communion among a distributed group linked by low- to moderate-bandwidth networking is a complex challenge. Some people favor technology-mediated communication as their most authentic way of sharing ideas and enjoying fellowship. Most people prefer face-to-face interaction but find the convenience of immediate access to others often outweighs the disadvantages of distributed sharing of ideas, experiences, and support. Groupware tools, a capable moderator, and shared interactivity and control are important for sustaining the vitality of virtual communities, as is occasional direct contact among participants. Otherwise, inactive virtual spaces must balance virtual interactivity and direct interaction to sustain a community of many people. A relationship based only on telephone communications lacks the vibrancy that face-to-face interchange provides. Similarly, while digital video will broaden the bandwidth of virtual interactions on information infrastructures, teleconferencing will never completely substitute for direct personal contact. We can expect a variety of social inventions to emerge that provide the best of both worlds; for example, national professional conferences may sponsor pre- and post-conference virtual communities that enable participants to make the most of the limited face-to-face time they have. Through their expertise in encouraging interactivity across disparate geographic locations, distance educators have important insights to contribute in the evolution of virtual communities.

Synthetic Environments. Another emerging capability for enhancing distributed learning is shared synthetic environments that extend our experiences beyond what we can encounter in the real world. Information infrastructures are not only channels for transmitting content but also communal virtual worlds that students can enter and explore. Just as single-user simulations allow an individual to interact with a model of reality (e.g., flying a virtual airplane), distributed simulations enable many people at different locations to inhabit and shape a common synthetic environment. For example, the U.S. Department of Defense uses distributed simulation technology to create virtual battlefields on which learners at remote sites develop collective military skills. The appearance and capabilities of graphically represented military equipment alter by second as the virtual battle, or "dual-war," evolves.

Distributed simulation is a representational container that can embody a broad range of educational and entertainment applications that use edutainment to promote distributed learning outside the classroom.

The vignette shows how education could be situated in a synthetic universe analogous to an authentic real-world environment, but one that is more intriguing. Moreover, such a distributed learning strategy leverages a huge base of sophisticated information technology—home video games and computer simulations as well as the substantial motivation inspired by the entertainment industry. Even without the added enhancement of visual imagery, the rise on the Internet of text-based synthetic environments (e.g., MUDs, MUSES, and MOOs) illustrates people's fascination with participatory virtual worlds. The continual evolution of distributed simulations based on participators' collaborative interactions keeps these shared virtual environments from becoming boring and stale. In contrast to traditional adventure games, in which the player wanders through someone else's fan.

**Vignette 1: Using Edutainment to Promote Distributed Learning—A Look Into the Future**

Rogier was unobtrusively sidling across the Bridge of the Starship Enterprise when the captain spotted him out of the corner of his eye. "Take the helm, Ensign Pulver," growled Captain Jean-Luc Picard. "And pilot a course through the corona of that star at light speed 1.999. We have astrophysical samples to collect. You'll have to guard against stray relativistic effects at that speed, but your shields cannot stand the radiation flux we would experience through traveling less quickly." Rogier had intended to sneak onto the Ecology Deck of the starship and put in a little work on his biology class project in controlling closed-system pollution levels, but no such luck. Worse yet, he suspected that the Vulcan communications officer watching him while she translated a message in French was in fact the "avatar" (a computer-graphics representation of a person) of a woman he admired who sat three rows behind him in his languages class. Of course, he could be wrong; she might be some teleporting into this simulation from who knows where, or she could even be a "knoebot" (a machine-based simulation personalized to use the instructor's job of directing an instructional simulation).

Buying a little time by summoning up the flot Light, Roger glanced curiously around the bridge to see what new artificats his fellow students had added since yesterday to this MUD (Multi-User Dimension or Dimension, a current type of adventure game in which participants collaboratively evolve a communal synthetic environment by continuously modifying its contents). In one corner, an intricate ecosystem creature was sitting in a transparent box, breathing a bluish-green atmosphere—maybe this was the long-awaited alien the anthropology and biology majors were creating as a mutual project. The 3-D regulators from his Nintendo+ set intensified the illusion that the lizard-like creature was staring right at him.

"Impulse engines to full speed, Mister!" barked Captain Picard. "This Mage [human expert guiding the evolution of a virtual environment] seems rather grumpy for a regular teacher," thought Rogier. "Maybe he's a visiting freeman from the new Neth 'Experts program." On his console, Rogier rapidly selected equa
tions that he hoped would yield the appropriate relationship for successfully navigating through the star's corona. He hoped to impress Captain Picard as a means of improving his chances for promotion. Last week's setback—developing motion sickness while "riding" on a virtual gas molecule that was illustrating Brownian motion—had not helped his chances.
tacy, the ability to personalize an environment and receive recognition from others for adding to the shared context is attractive to many people. Part of why we read fiction or watch dramatic productions is to escape the ordinary in a manner that increases our insights or refreshes us to plunge back into real-world challenges. Shared virtual experiences on the Internet can complement books, plays, television, movies, and concerts by taking us beyond the daily grind—the challenge is to move past escapism into metaphorical comprehension and catharsis.

**Sensory Immersion.** In addition to distributed simulation, advances in high-performance computing and communications also enable learners to experience sensory immersion in "artificial realities." Via an immersion interface based on computerized clothing and a head-mounted display, the participant feels that he or she is "inside" an artificial reality rather than viewing a synthetic environment through the screen of a computer monitor. Virtual reality is analogous to diving rather than looking into an aquarium window.

Using sensory immersion to present abstract, numeric data in tangible form is a powerful means of attaining insights into real-world phenomena. For example, "visualization" is an emerging type of rhetoric that enhances learning by using the sensory flux of the human visual system to find patterns in large amounts of information. People have very powerful pattern-recognition capabilities for images, much of our brain is "wired" dedicated to this purpose. As a result, when tabular data of numerical variables such as temperature, pressure, and velocity are presented graphically into graphical objects whose shifts in shape, texture, size, color, and motion convey the changing values of each variable, increased insights are often attained. For example, graphical data visualizations that model thunderstorm-related phenomena (e.g., down bursts, air flow, and cloud movements) are valuable in helping meteorologists and students understand the dynamics of these weather systems.

As information infrastructures increasingly enable people to access large databases across distance, visualization tools can expand human perceptions so that we recognize underlying relationships that would otherwise be swamped in a sea of numbers. One good way to enhance creativity is to make the familiar strange and the strange familiar. Adding sonification and even tactile sensations to visual imagery can make abstract things tangible, and vice versa. For example, simulating human perceptions (e.g., allowing a medical student to see the human body through X-ray vision like Superman's) is a powerful method for deepening learners' motivation and their intuitions about physical phenomena. My current research centers on assessing the potential value of sensory immersion and synthetic environments for learning material as disparate as electromagnetic fields and interpersonal sensibilities.

**Vignette 2**

Sensory Immersion, Virtual Collaboration, and Synthetic Environments: Distributed Learning in the 21st Century

Karen sat down at her educational workstation, currently configured as a lead chamber for electronics diagnosis/repair training. When she clicked logging in, the workstation acknowledged her readiness to begin Lesson 12, "Remediated Correction of Malfunctioning Communications Sensor." Her "knowbot" ([machine-based agent] established a telecommunication link to Phil, her partner in the exercise, who was sitting at a similar device in his home 30 miles away. "Why did I have the bad break to get paired with this clown?" she pondered, noting a hang-up expression on his face in the video window. "He probably spent last night partying instead of preparing for the lesson." A favorite saying of Phil's "for a multicolored, three-dimensional network of interconnections appeared, and would require care to remove without breaking. Meanwhile, Phil called up the CT for electronics repair. On the screen, a multicolored, three-dimensional network of interconnections appeared and began slowly rotating. He groaned; just looking at the knowledge web made his eyes hurt. Since the screen resolution was excellent, he suspected that last night's fourth margarita was the culprit. Phil said slowly, "Lesson 12," and a trail was highlighted in the pathway. If they were not incorporated into public school classrooms, teachers may find a decade from now that they have a smaller fraction of students enrolled and fewer taxpayers willing to provide funding.

**Making the Transformation**

Today, distance education is primarily used in selective situations to overcome problems of scale (not enough students in a single location) and rarity (a specialized subject not locally available). Such instruction is often seen as "half a loaf" pedagogy—it is better than nothing but not as good as face-to-face teaching. However, the global marketplace and emerging information infrastructures are changing this situation. Educators must help all students become adept at distance interaction because skills involving information-gathering from remote sources and collaborating with dispersed team members are as central to the future workplace as learning to perform structured tasks quickly was to the industrial revolution. Also, by increasing the diversity of human resources available to students, distributed learning can enhance equity and pluralism to prepare them for competition in the world marketplace. Virtual classrooms have a wider spectrum of peers with whom learners can collaborate than any single educational institution can afford.

In a few years, high-performance computing and communications will make knowledge utilities, virtual communities, shared synthetic environments, and sensory immersion as routine a part of everyday existence as the pliers and analogies while simultaneously monitoring a small window in the upper left corner of the screen that was beginning to fill with data from the diagnostic sensors on Karen's DataArm. Phil ignored several paragraphs of text displayed at the bottom of the screen. Because his learning style was predominantly visual and auditory, he preferred to have his voice read aloud in spoken English, be listened to as he vocalized the textual material, watching a graphical pointer maneuver over a bar chart. Three figures were gesturing near the top of the display, indicating that they knew related stories. On the right side of the monitor, an internet-based browser showed index entries grouped by issue, hardware configuration, and functional system.

Traversing the network at the speed with which Karen was working was difficult given his hangover, and he made several mistypes. "Knowledge base," said Phil slowly, "infer what the optical memory chip does as the three-dimensional quantum well superlattice." The voice of his knowbot suddenly responded, "you seem to be assuming a sensor flaw perhaps. ""Shut up!" Phil thought savagely, hitting the cut-off switch. He grumbled when he visualized his knowbot feeding the cognitive audit trial of his actions into the workstations of his trainer and the corporation's communications repair expert; he could not terminate those incriminating records. Phil cringed when he imagined his trainer's "avatar" giving him another lecture on his shortcomings. Meanwhile, he began phrasing an elaborate excuse to send his instructors via e-mail at the termination of the lesson. Meanwhile, Karen was exacerbated watching the window on her AR display in which Phil's diagnostic responses should have been appearing. "He's hopeless," she thought. Her knowbot's "consciousness sensor" [a biofeedback link that monitors user attention and mood] interrupted with a warning: "Your blood pressure is rising rapidly; this could trigger a migraine headache. "Why?" Karen asked sadly, "couldn't I have lived in the age when students learned from textbooks?"
telephone, television, radio, and newspaper are today. Distributed learning experiences will be seen as vital for all learners even when the same content could be taught face-to-face, and all teaching will have some attributes of distance education. Keeping a balance between virtual interaction and direct interchange will be important, however. Technology-mediated communication and experience supplement, but do not replace, immediate involvement in real settings.

High-performance computing and communications won't be a silver bullet that magically solves all problems of education; thoughtful and caring participation is vital for making these new capabilities truly valuable. Even then, a sloppily handwritten note delivered through surface mail may mean more to the recipient than an instantly transmitted, elegantly formatted electronic message. New media complement existing approaches to widen our repertoire of communication; properly designed, they need not eliminate choices or force us into high-tech, low-touch situations.

How a medium shapes its users, as well as its message, is a central issue in understanding the transformation of distance education into distributed learning. The telephone creates conversationals, and the book develops imaginers who can conjure a rich mental image from sparse symbols on a printed page. Much of television programming induces passive observers; other shows, such as Sesame Street and public affairs programs, can spark users' enthusiasm and enrich their perspectives.

As we move beyond naive “superhighway” concepts to see the true potential impact of information infrastructures, society will face powerful new interactive media capable of great good or ill. Today's “couch potatoes,” vicariously living in the fantasy world of television, could become tomorrow's “couch fungi,” immersed as protagonists in 3-D soap operas while the real world deteriorates. The most significant influence on the evolution of distance education will not be the technical development of more powerful devices but the professional development of wise designers, educators, and learners.

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Note: Contact the author at the above address for a list of other articles related to this topic.