Educating the Net Generation

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CHAPTER 15

Planning for Neomillennial Learning Styles: Implications for Investments in Technology and Faculty

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Today's students have been described as having an information age mindset, being Millennials or members of the Net Generation. While this portrayal of generational learning styles can be oversimplified, the technology and media used by children during their formative years do have an influence on how they learn, as do the media used by adults. However, technology is no more static than people. The Internet is a constantly evolving infrastructure that now supports many media, including such disparate applications as "groupware" for virtual collaboration, asynchronous threaded discussions, multi-user virtual environments, videoconferencing, and mobile, location-aware wireless devices such as personal digital assistants (PDAs) with embedded global positioning system (GPS) capabilities.[1] Research indicates that each of these media, when designed for education, fosters particular types of interactions that enable—and undercut—various learning styles. Rather than describe the present (or the past), this chapter looks at the continuing evolution of computers and telecommunications and speculates on new learning styles emerging media may enable, as well as how higher education can prepare for this shift.

How Emerging Media Foster Neomillennial Learning Styles

Over the next decade, three complementary interfaces will shape how people learn:[2]

- **The familiar "world to the desktop."** Provides access to distant experts and archives and enables collaborations, mentoring relationships, and virtual

communities of practice. This interface is evolving through initiatives such as Internet2.

- **"Alice in Wonderland" multiuser virtual environments (MUVEs).** Participants' avatars (self-created digital characters) interact with computer-based agents and digital artifacts in virtual contexts. The initial stages of studies on shared virtual environments are characterized by advances in Internet games and work in virtual reality.
- **Ubiquitous computing.** Mobile wireless devices infuse virtual resources as we move through the real world. The early stages of "augmented reality" interfaces are characterized by research on the role of "smart objects" and "intelligent contexts" in learning and doing.

Net Generation learning styles stem primarily from the world-to-the-desktop interface; however, the growing prevalence of interfaces to virtual environments and augmented realities is beginning to foster so-called neomillennial learning styles in users of all ages. The crucial factor leading to the augmentation of millennial learning styles with neomillennial characteristics is that the world-to-the-desktop interface is not psychologically immersive, while in contrast virtual environments and augmented realities induce a strong sense of "presence." This immersion in virtual environments and augmented realities shapes participants' learning styles beyond what using sophisticated computers and telecommunications has fostered thus far, with multiple implications for higher education.

How Immersive Presence Enhances Learning

Immersion is the subjective impression that one is participating in a comprehensive, realistic experience.[3] Immersion in a mediated, simulated experience (such as a virtual environment or an augmented reality) involves the willing suspension of disbelief. As an example, when watching a Harry Potter movie on an IMAX screen, the plot and characters coupled with visual and auditory input produce a sense of psychological immersion: the audience does not focus on the sensations of sitting in a theatre seat but instead on being present in a wizarding "world," observing a fascinating series of events. The example is weak, however, because the experience is passive, as opposed to the stronger immersion induced when participants shape an experience rather than just observe it.

The design of mediated-immersion simulated learning experiences depends on actional, symbolic, and sensory factors.[4] Inducing actional immersion involves empowering the participant in an experience to initiate actions that have novel,

intriguing consequences. For example, when a baby is learning to walk, the degree of concentration this activity creates in the child is extraordinary. Discovering new capabilities to shape one's environment is highly motivating and sharply focuses attention.

Inducing a participant's symbolic immersion involves triggering powerful semantic associations via the content of an experience. As an illustration, reading a horror novel at midnight in a strange house builds a mounting sense of terror, even though one's physical context is unchanging and rationally safe. Invoking intellectual, emotional, and normative archetypes deepens the experience by imposing a complex overlay of associative mental models.

Beyond actional and symbolic immersion, advances in interface technology are now creating virtual environments and augmented realities that induce a psychological sense of sensory and physical immersion. Sensory immersion is relatively easy to foster in augmented realities, which are set in physical environments. Psychological immersion is achievable in MUVEs by design strategies that combine actional, symbolic, and sensory factors in manipulating an avatar to further the suspension of disbelief that the participant represented by the avatar is "inside" a virtual environment: the equivalent of diving rather than riding in a glass-bottomed boat.

For example, one design strategy to induce psychological immersion in virtual environments is using egocentric rather than exocentric frames of reference. As Salzman described,

> The exocentric frame of reference (FOR) provides a view of an object, space, or phenomena from the outside, while the egocentric FOR provides a view of the object, space, or phenomena from within. Imagine a dollhouse. As a human, you can peer at the house from a number of angles, you can reach into it to feel the rugs and furniture with your fingers, and you may even be able to stick your head inside; but you can only imagine what it would be like to be a doll living inside that house. You experience the dollhouse from the exocentric FOR. If you were the doll inside the house, you would experience the house and its furnishings from within—walking on the rugs, sitting in the chairs, and sleeping in the bed; but you would only be able to imagine what it would be like to be the human on the outside looking in. You would experience the dollhouse from the egocentric FOR. Each FOR would give you different kinds of

information about the dollhouse and it might shape what you come to know about that house.[5]

The research on virtual reality Salzman and I conducted on frames of reference found that the exocentric and the egocentric FORs have different strengths for learning. Our studies established that learning ideally involves a "bicentric" perspective alternating between egocentric and exocentric FORs.

We also researched how each of these three perspectives—the egocentric, the exocentric, and the bicentric—influenced participants' motivation and learning styles.[6] One major advantage of egocentric perspectives is that they enable participants' actional immersion and motivation more strongly than exocentric FORs, which are better suited for dispassionate observer roles. Another advantage of the egocentric FOR is that this perspective enables "situated" learning, while exocentric perspectives foster insights gained from distancing oneself from the context (seeing the forest rather than the trees). Bicentric FORs combine the strengths of each perspective.

Situated Learning and Transfer via Psychological Immersion

The capability of computer interfaces to foster psychological immersion enables technology-intensive educational experiences that draw on a powerful pedagogy: situated learning. Reports such as the National Research Council's study[7] delineate theoretical constructs for understanding teaching and learning. The major schools of thought cited are behaviorist theories of learning (presentational instruction), cognitivist theories of learning (tutoring and guided learning by doing), and situated theories of learning (mentoring and apprenticeships in communities of practice). Situated learning requires authentic contexts, activities, and assessment coupled with guidance from expert modeling, mentoring, and "legitimate peripheral participation."[8] As an example of legitimate peripheral participation, graduate students work within the laboratories of expert researchers, who model the practice of scholarship. These students interact with experts in research as well as with other members of the research team who understand the complex processes of scholarship to varying degrees. While in these laboratories, students gradually move from novice researchers to more advanced roles, with the skills and expectations for them evolving.

Potentially quite powerful, situated learning is much less used for instruction than behaviorist or cognitivist approaches. This is largely because creating tacit,

relatively unstructured learning in complex real-world settings is difficult. However, virtual environments and ubiquitous computing can draw on the power of situated learning by creating immersive, extended experiences with problems and contexts similar to the real world.[9] In particular, MUVEs and real-world settings augmented with virtual information provide the capability to create problem-solving communities in which participants can gain knowledge and skills through interacting with other participants who have varied levels of skills, enabling legitimate peripheral participation driven by intrinsic sociocultural forces.

Situated learning is important in part because of the crucial issue of *transfer.* Transfer is defined as the application of knowledge learned in one situation to another situation and is demonstrated if instruction on a learning task leads to improved performance on a transfer task, typically a skilled performance in a real-world setting.[10] One of the major criticisms of instruction today is the low rate of transfer generated by conventional instruction. Even students who excel in schooling or training settings often are unable to apply what they have learned to similar real-world contexts. Situated learning addresses this challenge by making the setting in which learning takes place similar to the real-world context for performance in work or personal life.[11] Learning in well-designed digital contexts can lead to the replication in the real world of behaviors successful in simulated environments.[12]

Moreover, the evolution of an individual's or group's identity is an important type of learning for which simulated experiences situated in virtual environments or augmented realities are well suited. Reflecting on and refining an individual identity is often a significant issue for higher education students of all ages, and learning to evolve group and organizational identity is a crucial skill in enabling innovation and in adapting to shifting contexts. The social sciences see both the self and the organization as often fragmented, with complementary parts, rather than centralized and unitary. Identity "play" through trying on various representations of the self and the group in virtual environments provides a means for different sides of a person or team to find common ground and the opportunity for synthesis and evolution.

Immersion is important in this process of identity exploration because virtual identity is unfettered by physical attributes such as gender, race, and disabilities. Virtual environments based on games such as EverQuest (http://eqlive.station.sony.com/) and simulations such as Whyville (http://www.whyville.net/) illustrate how participants take advantage of fluidity in the identities they present. Simulations in virtual

environments and augmented realities increase the value of these explorations by providing realistic feedback on how the real world responds to various patterns of individual and group behavior.[13]

But what is so special about the egocentric perspectives and situated learning now enabled by emerging media? After all, each of us lives with an egocentric perspective in the real world and has many opportunities for situated learning without using technology. One attribute that makes mediated immersion different and powerful is the ability to access information resources and psychosocial community distributed across distance and time, broadening and deepening experience. A second important attribute is the ability to create interactions and activities in mediated experience not possible in the real world, such as teleporting within a virtual environment, enabling a distant person to see a real-time image of your local environment, or interacting with a (simulated) chemical spill in a busy public setting. Both of these attributes are actualized in the Alice-in-Wonderland interface.

Immersion in Virtual Educational Environments

Most students now using MUVEs do so in the context of gaming. As Steinkuehler noted,

> Massively multiplayer online games (MMOGs) are highly graphical 2- or 3-D videogames played online, allowing individuals, through their self-created digital characters, or "avatars," to interact not only with the gaming software (the designed environment of the game and the computer-controlled characters within it) but with other players' avatars as well. These virtual worlds are persistent social and material worlds, loosely structured by open-ended (fantasy) narratives, where players are largely free to do as they please—slay ogres, siege castles, barter goods in town, or shake the fruit out of trees.... Thanks to out-of-game trading of in-game items, Norrath, the virtual setting of the MMOG EverQuest, is the seventy-seventh largest economy in the real world, with a GNP per capita between that of Russia and Bulgaria. One platinum piece, the unit of currency in Norrath, trades on real world exchange markets higher than both the Yen and the Lira (Castronova, 2001).[14]

Black noted that players of all ages are involved in many different MMOGs and in ancillary activities such as fanfiction Web sites, where people enamored with

a particular game or book can add to its genre with their own writing.[15] (These fanfiction archives are substantial; Black documented a multifandom archive that contains hundreds of thousands works of original fanfiction, including over 20,000 Final Fantasy video game–related fictions and approximately 127,000 Harry Potter–based texts.) While the content of these games and activities often does not lead to knowledge useful in the real world, rich types of learning and identity formation do take place in these environments, fostering neomillennial learning styles based on characteristics of immersive mediated interaction. The research my colleagues and I are conducting on MUVEs for educating young people about higher order inquiry skills illustrates this.

The River City MUVE[16] is centered on skills of hypothesis formation and experimental design, as well as on content related to national standards and assessments in biology and ecology. We are demonstrating how students can gain this knowledge through immersive simulations, interactive virtual museum exhibits, and "participatory" historical situations. Students learn to behave as scientists while they collaboratively identify problems through observation and inference, form and test hypotheses, and deduce evidence-based conclusions about underlying causes.

The River City virtual world consists of a city with a river running through it; different forms of terrain that influence water runoff; and various neighborhoods, industries, and institutions, such as a hospital and a university (http://muve.gse.harvard.edu/muvees2003/). Through egocentric perspectives, the learners themselves populate the city, along with computer-based agents, digital objects that can include audio or video clips, and the avatars of instructors (see Figure 1). River City is typical of the United States in the late 19th century; the right-hand window in Figure 1 depicts how we use museum artifacts to illustrate building exteriors and street scenes from that historical period. In addition, throughout the world students encounter residents of River City and "overhear" their conversations with one another. These computer-based "agents" disclose information and provide indirect clues about what is going on in River City.

Content in the right-hand interface window shifts based on what the participant encounters or activates in the virtual environment (see Figure 2). In this case, the right hand window presents water quality data from one of eleven water-sampling stations in River City. Through data gathering, students observe the patterns that emerge and wrestle with questions such as, why are many more poor people getting sick than rich people? Multiple causal factors are involved, including polluted

Figure 1. Talking with an Agent

Figure 2. Collecting Water Quality Data

water runoff to low-lying areas, insect vectors in swampy areas, overcrowding, and the cost of access to medical care.

Dialogue is shown in the text box below these two windows. To aid their interactions, participants also have access to one-click interface features that enable the avatar to express (through stylized postures and gestures) emotions such as happiness, sadness, and anger. These interface features also allow looking upward or downward, as well as seeing the world from a first-person perspective or

from behind one's own body in a third-person viewpoint. In addition, learners can interact with digital artifacts and tools, such as a virtual microscope in which the image from the microscope slide appears in the right-hand interface window.

Multiple teams of students can access the MUVE simultaneously, each individual manipulating an avatar which is "sent back in time" to this virtual environment. Students must collaborate to share the data each team collects. Beyond textual conversation, students can project to each other "snapshots" of their current individual point of view (when someone has discovered an item of general interest) and also can "teleport" to join anyone on their team for joint investigation. Each time a team reenters the world, several months of time have passed in River City, so learners can track the dynamic evolution of local problems.

Three strands of illness in River City (waterborne, airborne, and insectborne) are integrated with historical, social, and geographical content to allow students to experience the realities of disentangling multicausal problems embedded within a complex environment. In our research on this educational MUVE based on situated learning, we are studying usability, student motivation, student learning, and classroom implementation issues. The results thus far are promising:

- All learners are highly motivated, including students typically unengaged in classroom settings.
- All students build fluency in distributed modes of communication and expression and value using multiple media because each empowers different types of communication, activities, experiences, and expressions.
- Even typically low-performing students can master complex inquiry skills and sophisticated content.
- Shifts in the pedagogy within the MUVE alter the pattern of student performance.

We are now conducting large-scale studies to assess the strengths and limits of this educational approach, in particular how MUVEs shape students' learning styles.[17] Other researchers who study educational MUVEs designed for young people, such as Quest Atlantis (http://atlantis.crlt.indiana.edu/start/index.html) and Whyville (http://www.whyville.net), also are assessing how immersive virtual environments influence their participants' learning styles.[18a,b] These studies are documenting how storyline and players' progression through various levels of capability/power enhance motivation and integrate content and skills, as well as how identity play complements and extends learning. Research indicates that active learning based on experience (real and simulated) that includes frequent

opportunities for reflection via bicentric frames of reference is both engaging and powerful for a broad spectrum of students.

Immersion in Educational Augmented Realities

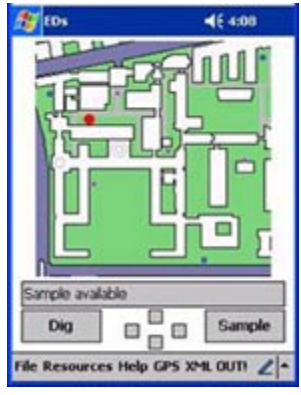
An emerging interface that complements the Alice-in-Wonderland immersion of MUVEs is augmented reality via ubiquitous computing, in which mobile wireless devices immerse participants in virtual resources as they move through the real world. As one example, Hsi and colleagues have developed a device called eXspot intended to support, record, and extend exhibit-based, informal science learning at the Exploratorium, an interactive hands-on museum of art, science, and perception located in San Francisco.[19] eXspot participants visiting the Exploratorium carry a card with a radio frequency interference device (RFID) tag embedded. As various exhibits are viewed, these visitors can swipe the card on a RFID reader at the exhibit. At any time later, participants can view a museum-generated personal Web page listing the dates the museum was visited and specific exhibits swiped that day. Personal photos taken at the exhibits and online content about exhibits are also available. Research shows that many participants value this functionality and choose to access the Web page after leaving the museum.

As another illustration of ubiquitous computing for learning, Klopfer and colleagues are developing augmented reality (AR) handheld-computer simulations that embed students inside lifelike problem-solving situations to help them understand complex scientific and social dynamics (http://education.mit.edu/ar). Participants in these distributed simulations use location-aware handheld computers (with GPS technology), allowing users to physically move throughout a real-world location while collecting place-dependent simulated field data, interviewing virtual characters, and collaboratively investigating simulated scenarios.

For example, their Environmental Detectives AR simulation engages high school and university students in a real-world environmental consulting scenario not possible to implement in a classroom setting.[20] Students role-play environmental scientists investigating a rash of health concerns on the MIT campus linked to the release of toxins in the water supply. Working in teams (see Figure 3), players attempt to identify the contaminant, chart its path through the environment, and devise possible plans for remediation. As participants physically move about campus, their handheld devices respond to their location (see Figure 4), allowing them to collect simulated field data from the water and soil, interview virtual characters, and perform desktop research using miniwebs of data. At the end

Figure 3. Students in Augmented Reality

Figure 4. Handheld Location on Campus



of the exercise, teams compile their data using peer-to-peer communication and synthesize their findings.

Initial research on Environmental Detectives and other AR-based educational simulations demonstrates that this type of immersive, situated learning can effectively engage students in critical thinking about authentic scenarios.[21] Students participating in these simulations indicated that they felt invested in the situations and were motivated to solve the problem. They moved nearly seamlessly between

the real world and the information being presented to them on their handheld computers as they collected data from virtual scientific instruments and accounts from virtual experts and witnesses. Students were most effective in learning and problem-solving when they collectively sought, sieved, and synthesized experiences rather than individually locating and absorbing information from some single best source.

How Emerging Media are Fostering Mediated Immersion Throughout Life

Quite apart from educational innovation based on emerging media, people's daily use of new devices is shifting their lifestyles toward frequent mediated immersion, which in turn is shaping their learning styles toward neomillennial characteristics. Prognosticators such as Howard Rheingold[22] and William Mitchell[23] speculated about the impacts on individuals and civilization as new digital media pervade every aspect of life. For example, Rheingold depicted a future based on distributed networks of information, communication, and activity—as contrasted to the historic pattern of lifestyles centered on face-to-face groups interacting with local resources. Members of the same physical group may have very different personal communities as their major sources of sociability, support, information, a sense of belonging, and social identity. He sees these distributed communities, created through mediated immersion, as far-flung, loosely bounded, sparsely knit, and fragmentary.

Rheingold's forecasts draw on lifestyles seen at present among young people who are high-end users of new media, as well as the visions of researchers and businesses developing products and services based on virtual environments and ubiquitous computing. In a world composed of these high-end users with access to these new products and services, the following types of experiences would pervade people's lifestyles:

- Mobile wireless devices (MWDs), such as gaming devices, cell phones, digital music players, and PDAs would access media that are virtually connected to locations (such as street signs linked to online maps), objects (such as books linked to online reviews), and services (such as restaurants linked to ratings by their customers).
- MWDs would access every type of data service anywhere (such as banking and stock market information, weather, tickets and reservations, and transport schedules).

- MWDs would locate strangers nearby who have identified themselves as having common interests (such as people interested in dating and matched on desired attributes; friends of friends; fellow gamers; fans of a certain team, actor, or author).
- Rather than having core identities defined through a primarily local set of roles and relationships, people would express varied aspects of their multifaceted identities through alternate extended experiences in distributed virtual environments and augmented realities.

Rheingold painted a largely positive picture of this "social revolution" while articulating some concerns about privacy, quality of life, and loss of humanity.

The technology infrastructure necessary for these lifestyles is emerging. As Baker and Green[24] noted, one-third of U.S. households now have broadband access to the Internet. In the past three years, 14 million U.S. families have linked their computers with wireless home networks. Some 55 percent of Americans now carry cell phones, and the first data services—radio, photos, and short video clips—are starting to take off.

Mitchell's forecasts[25] are similar to Rheingold's in many respects. He too envisions largely tribal lifestyles distributed across dispersed, fragmented, fluctuating habitats: electronic nomads wandering among virtual campfires. People's senses and physical agency are extended outward and into the intangible, at considerable cost to individual privacy. Individual identity is continuously reformed via an ever-shifting series of networking with others and with tools. People express themselves through nonlinear, associational webs of representations rather than linear "stories" and co-design services rather than selecting a precustomized variant from a menu of possibilities.

Whether these forecasts of major shifts in society are accurate is uncertain. Probably, some people will choose the distributed immersive lifestyles Rheingold and Mitchell portray, while others will have less intensive interactions with new media that do not lead to dramatic changes in their activities or identity. More and more, though, people of all ages will have lifestyles involving frequent immersion in both virtual and augmented reality. How might distributed, immersive media be designed specifically for education, and what neomillennial learning styles might they induce?

Neomillennial Learning Styles Based on Mediated Immersion

Emerging devices, tools, media, and virtual environments offer opportunities for creating new types of learning communities for students and teachers. Bielaczyc and Collins indicated that:

> The defining quality of a learning community is that there is a culture of learning, in which everyone is involved in a collective effort of understanding. There are four characteristics that such a culture must have: (1) diversity of expertise among its members, who are valued for their contributions and given support to develop, (2) a shared objective of continually advancing the collective knowledge and skills, (3) an emphasis on learning how to learn, and (4) mechanisms for sharing what is learned. If a learning community is presented with a problem, then the learning community can bring its collective knowledge to bear on the problem. It is not necessary that each member assimilate everything that the community knows, but each should know who within the community has relevant expertise to address any problem. This is a radical departure from the traditional view of schooling, with its emphasis on individual knowledge and performance, and the expectation that students will acquire the same body of knowledge at the same time.[26]

Mediated immersion creates distributed learning communities, which have different strengths and limits than location-bound learning communities confined to classroom settings and centered on the teacher and archival materials.[27] In particular, distributed learning communities infuse education throughout students' lives, orchestrating the contributions of many knowledge sources embedded in real-world settings outside of schooling and fostering neomillennial learning styles.

The benefits of learning styles enhanced by mediated immersion in distributed learning communities are illustrated in Table 1.

Mediated immersion likely has other influences on learning style yet to be discovered, but these initial findings have a variety of implications for strategic planning and investment in higher education.

Table 1. Neomillenial Versus Millennial Learning Styles

Neomillennial Learning	Millennial Learning
Fluency in multiple media, values each for the types of communication, activities, experiences, and expressions it empowers.	Centers on working within a single medium best suited to an individual's style and preferences
Learning based on collectively seeking, sieving, and synthesizing experiences rather than individually locating and absorbing information from some single best source; prefers communal learning in diverse, tacit, situated experiences; values knowledge distributed across a community and a context, as well as within an individual.	Solo integration of divergent, explicit information sources
Active learning based on experience (real and simulated) that includes frequent opportunities for embedded reflection (for example, infusing experiences in the Virtual University simulation <http://www.virtual-u.org/> in a course on university leadership); values bicentric, immersive frames of reference that infuse guidance and reflection into learning-by-doing.	Learning experiences that separate action and experience into different phases
Expression through nonlinear, associational webs of representations rather than linear stories (for example, authoring a simulation and a Web page to express understanding rather than writing a paper); uses representations involving richly associated, situated simulations.	Uses branching, but largely hierarchical, multimedia
Co-design of learning experiences personalized to individual needs and preferences.	Emphasizes selecting a precustomized variant from a range of services offered

Implications for Higher Education's Strategic Investments

Table 2 presents speculations about how the emergence of neomillennial learning styles may influence higher education. Emphasis is placed on implications for strategic investments in physical plant, technology infrastructure, and professional development.

These ideas are admittedly speculative rather than based on detailed evidence and are presented to stimulate reaction and dialogue about these trends.

If we accept much of the analysis above, four implications for investments in physical and technological infrastructure are apparent:

- **Wireless everywhere—**provide total coverage of the campus; subsidize uniform mobile wireless devices offering convergence of media (phone, PDA, gaming, Internet)
- **Multipurpose habitats—**creating layered/blended/personalizable places rather than specialized locations (such as computer labs)
- Augmented reality—experiment with smart objects and intelligent contexts (via GPS and RFID tags and transceivers)
- **"Mirroring"—**experiment with virtual environments that replicate physical settings but offer "magical" capabilities for immersive experience

This is not to imply that campuses should immediately undertake massive shifts toward these four themes, but rather that students of all ages with increasingly neomillennial learning styles will be drawn to colleges and universities that have these capabilities.

Four implications for investments in professional development also are apparent. Faculty will increasingly need capabilities in:

- **Co-design—**developing learning experiences students can personalize
- **Co-instruction—**using knowledge sharing among students as a major source of content and pedagogy
- **Guided social constructivist and situated learning pedagogies—**infusing case-based participatory simulations into presentational/assimilative instruction
- **Assessment beyond tests and papers—**evaluating collaborative, nonlinear, associational webs of representations; using peer-developed and peer-rated forms of assessment; employing student assessments to provide formative feedback on faculty effectiveness

Some of these shifts are controversial for many faculty; all involve "unlearning" almost unconscious beliefs, assumptions, and values about the nature of teaching, learning, and the academy. Professional development that requires unlearning necessitates high levels of emotional/social support in addition to mastering the intellectual/technical dimensions involved. The ideal form for this type of professional development is distributed learning communities so that the learning process is consistent with the knowledge and culture to be acquired. In other words, faculty must themselves experience mediated immersion and develop neomillennial learning styles to continue teaching effectively as the nature of students alters.

Table 2. Speculations About Higher Education Now and in the Future

Dimension	Now	Future
Location and physical infrastructure	Locations and physical infrastructures configured to accomplish specialized forms of activity (such as dorm room or apartment, classrooms, student center, library, computer lab) Direct physical manipulation of equipment in science lab	Wearable devices and universal wireless coverage mean access, information, computational power no longer tied to physical space (such as a computer lab) Most activities distributed across space and time, so tailoring space to particular purposes (such as library reading rooms) often no longer necessary Notion of place is layered/blended/multiple; mobility and nomadicity prevalent among dispersed, fragmented, fluctuating habitats (for example, coffeehouses near campus) Virtual simulations complement equipment-based science labs
Smart objects and intelligent contexts	Inert objects and contexts with information available only via signage Physical presence on campus only way of "being there"	Information virtually connected to locations (such as campus buildings linked to online maps) and objects (such as textbooks linked to course ratings by students) "Mirroring": Immersive virtual environments provide replicas of distant physical settings
Social group	Roommates, members of dorm or apartment, classmates	Far-flung, loosely bounded, sparsely knit, and fragmentary communities (independent of cohabitation, common course schedules, or enrollment at a particular campus)
Collaboration	Collaboration dependent on shared physical presence or cumbersome virtual mechanisms	Middleware, interoperability, open content, and open source enable seamless information sharing, collaborative virtual manipulation of tools and media, shared authoring and design, collective critiquing
Personal customization	Little or none	"Napsterism": recombining others' designs to personally tailored configurations[28] Customized services based on data mining for patterns of personal characteristics and behaviors

Cognition	Finding information Sequential assimilation of linear information stream	Seeking, sieving, synthesizing disparate sources of data Multitasking among disparate experiences and information sources Focus on associative interconnections among chunks of information Constant reflection on and sharing of experience Mind extended via distributed cognition, sensation, memory
Identity	Identity expressed in the context of face-to-face groups interacting with local resources	Virtual identity unfettered by physical attributes such as gender, race, disabilities Self continuously reformed via an ever-shifting series of distributed networking with others and with tools Self as an electronic nomad wandering among virtual campfires, no longer needing a local physical infrastructure to articulate identity
Instruction	Instructor designs and delivers one-size-fits-all content, pedagogy, and assessment Students are passive recipients	Learners influence design of content, pedagogy, and assessment based on individual preferences and needs Knowledge sharing among students as a major source of content Guided social constructivism and situated learning as major forms of pedagogy Case-based participatory simulations complement presentational/assimilative instruction
Assessment	Student products generally tests or papers Grading centers on individual performance Students provide summative feedback on instructional effectiveness	Student products often involve nonlinear, associational webs of representations (for example, authoring a simulation and a Web page to express understanding of an internship rather than authoring a paper that synthesizes expert opinions) Peer-developed and peer-rated forms of assessment complement faculty grading, which is often based on individual accomplishment in a team performance context Assessments provide formative feedback on instructional effectiveness

Conclusion

While generational descriptions can be useful, they also oversimplify. Differences among individuals are greater than dissimilarities between groups, so students in any age cohort will present a mixture of neomillennial, millennial, and traditional learning styles. Predictions of the future also carry risk. The technologies discussed are emerging rather than mature, so their final form and influences on users are not fully understood. A substantial number of faculty and administrators will likely dismiss and resist some of the ideas and recommendations presented here.

However, widespread discussion among members of the academy about the trends delineated above is important, regardless of whether at the end of that dialogue those involved agree with these speculative conclusions. Further, to the extent that some of these ideas about neomillennial learning styles are accurate, campuses that make strategic investments in physical plant, technical infrastructure, and professional development along the dimensions suggested will gain a considerable competitive advantage in both recruiting top students and teaching them effectively.

Endnotes

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