

# 2020 CLASSROOM

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*Imagine a group of students from around the nation in the science classroom of the future as they embark on a mission of exploration. The room is transformed into a fully immersive aural and visual environment that makes them feel like they are really in the same place together. Like deep-sea divers, they move through a compelling landscape of continuous activity. Together they begin to travel through a human cell. As they move through this beautiful yet unfamiliar landscape of curious objects, the immersive environment entices them to ask questions of each other and their teacher, to explore fundamental principles, and to form robust models of complex processes. They interact with each other and with the environment in a natural way with language and gestures. For them, from this moment on, “science” and “learning” will never be the same.*

A new paradigm for K-12 education will evolve over the next 20 years as innovative information technology and pedagogy are integrated into the learning environment. This process is being fueled by two factors: broadband Internet capability and the emergence of immersive technologies. When these technologies are combined, the Internet as we know it today will be transformed from a low fidelity medium for browsing information to a high fidelity medium that delivers rich and immersive experiences.

These new remote immersion systems will bring interactive and stimulating classroom experiences to all student populations – regardless of location. Classroom boundaries will fade as students and teachers are brought together by high-resolution video and immersive 3D shared environments that allow natural discussion, collaboration, and interaction among physically distant participants. With remote immersion, students and teachers will investigate, play, explore, and learn together in an environment that dynamically adapts to the content – from a biology laboratory to a visit to the aquarium.

The transformation of the Internet into a system for rich experiences will bring about the creation of

massive distributed on-line archives of past lectures, interactive presentations, simulations, proficiency testing, and problem presentations. This new content, designed specifically for these new technologies, will replace current textbooks and workbooks with a national resource of high-production and content quality materials, cross-indexed and customized for individuals or classes. Once created, the archives will be updated and further improved by continuous contributions and links from teachers, production groups, and authors anywhere.

Advances in information management technology will be integrated with both the delivery and content creation technologies to address the critical need for meaningful learning assessment. Rather than relying on current periodic testing results, automated tracking of students’ progress will provide statistical models of presentation sequences and paths, providing instant feedback to the student, the instructors, and administrators on progress or problems in the curriculum and its presentation.

There is a great need within the education community for such innovations and the pressure to make changes is being felt by schools at all levels. While information and digital media technology has been progressing at breakneck speeds over the past decade, unfortunately little has changed in the delivery and the design of the curriculum. The majority of efforts involving technology in education have focused on CD-ROMs or web sites containing little more than digitized versions of textbooks, or broadcast lectures with poor quality audio and video. Little has been done to design the content to take advantage of the potential of new delivery mechanisms. Technology up to now has been viewed as a way of reaching a larger audience, and not as the enabler of new learning paradigms.

We envision a new partnership evolving between technology and pedagogy—a partnership that will result in a new education paradigm. Teachers and students might be thousands of

miles apart, yet they will appear and sound to each other as if they are in the same classroom. Facilitated by unobtrusive picture and sound display devices, the infrastructure will give them a strong sense of presence, as if they are actually in the room together. Students will be able to “touch” objects in a faraway museum or “feel” forces in a virtual physics experiment through the use of haptics (touch-based technology). Teachers will be able to search for past lectures that best suit the needs of the session at this time. Data acquired automatically from the student’s interactions in this immersive environment will be captured and used to optimize the lesson progression. The term interactivity will be transformed from mouse-clicking and instant messaging to realistic, life-sized representations of teachers and classmates sitting next to you and talking. Imagine students interacting with avatars of James Watson and Francis Crick tutoring and guiding them on the discovery of the DNA structure. Imagine students immersed in a role playing experience at the Continental Congress during the Revolutionary War era. This is what remote immersion can do for education.

As appealing as this vision may sound, the truly revolutionary transformation will take place at the core—the dramatic reformation of our teaching methods themselves. New approaches will be developed for content authoring and modeling for simulation and for creating models of learning and assessment to measure the progress of students and guide them through the learning and problem-solving process. Students will interact with content material, explore challenges and perform inquiry-driven collaborative investigations, using an array of virtual laboratory tools and simulations. This new education environment will incorporate 3D computer animation and graphics, real-time image rendering, multichannel immersive audio, video, text, and haptics. Techniques that promote a high degree of student attention, goal attainment motivation, and satisfaction will be adapted from approaches already much better understood and employed by the gaming industry.

New multimedia and Internet technologies are creating novel ways to teach and learn through this very process of creating new ways to see, hear, and

touch. From an educational viewpoint, the use of sensory immersion has never been investigated. There is evidence from learning and psychology research indicating that memory is significantly enhanced by spatial associations. For example, optimal recall is achieved when an experience is not only captured as a set of sound and image streams, but when these are reproduced in such a fashion that the replay experience preserves the spatial relationships among the various elements.

How will this paradigm of bringing remote teachers and students together improve our standard classroom where the teacher and students are already in one place? It extends the classroom, opening it up to a vast treasure trove of educational experiences beyond the physical room walls and delivered in specific ways designed and crafted to enhance learning and understanding. Clearly, when the teachers and students are physically in the same classroom, the technology will still deliver experiences and materials in a way that enhances learning. This will also open the door to consistent and continued education for children with disabilities, or those in medical institutions, or those with difficulties traveling to a classroom.

The new paradigm of K-12 education we envision will evolve steadily over the next decade. As the technologies are introduced, we also envision the transformation of society in countless other ways, including the ways we communicate socially, conduct business, produce goods, and entertain ourselves.

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*The Integrated Media Systems Center in the School of Engineering at the University of Southern California has pursued scientific research and the application of information technology to K-12 education since its inception in 1996 as the National Science Foundation’s Engineering Research Center for multimedia and Internet research. Through its “2020 Classroom” project, IMSC is developing a prototype that integrates remote immersion with tools for creating pedagogically*

sound curriculum for such environments, as well as novel methods for learning assessment. IMSC also carries out a successful cross-disciplinary program of research, education, community outreach, industry collaboration, and technology transfer. The Center has developed such unique immersive technologies as 3D face modeling and animation; streaming media servers; multichannel immersive audio; and Immersion™ panoramic video. Other research areas include speech processing, haptic devices, data compression, and wireless communications.



Ulrich Neumann is the Charles Lee Powell Professor of Engineering and an Associate Professor of Computer Science at the University of Southern California. He earned an MSEE from SUNY at Buffalo in 1980 and he completed his computer science Ph.D. at the University of North Carolina at Chapel Hill in 1993 where his focus was on parallel algorithms for interactive volume-visualization. His current research relates to immersive environments and virtual humans.

He won a National Science Foundation CAREER award in 1995 and the Jr. Faculty Research award at USC in 1999. He was an Associate Editor for the IEEE Transactions on Multimedia from 1999-2002. Dr. Neumann is currently Director of the Integrated Media Systems Center (IMSC), the only National Science Foundation Engineering Research Center in multimedia and Internet technologies. IMSC includes over twenty-five faculty participating with more than twenty corporate partners pursuing media

systems research. In his commercial career, Dr. Neumann designed multiprocessor graphics and DSP systems, co-founded a video game corporation, and independently developed and licensed electronic products.

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Chris Kyriakakis is an Associate Professor of Electrical Engineering at USC and the Director of the Immersive Audio Laboratory that is part of the Integrated Media Systems Center (IMSC) an NSF Engineering Research Center. He received his BS from Caltech in 1985 and his PhD from USC in 1993. His research is focused on signal processing, acoustical, and psychoacoustical methods for capturing and rendering immersive audio environments, as well as delivering them over high bandwidth networks. At IMSC he is the Research Area Director for Sensory Interfaces and is in charge of 2020Classroom, a project examining the integration of immersive technology and novel curriculum design for new learning paradigms. Prof. Kyriakakis is a member of the IEEE, a member of the IEEE Technical Committee on Multimedia, the Audio Engineering Society, and the Acoustical Society of America.

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