

# **Commission on the Future of Higher Education**

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## **Opportunities for technology supported instruction in higher education**

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I am a Professor of Computer Science & Engineering at the University of Washington. About 10 years ago my career took a major shift, away from traditional research in computer science to working with educational technology, where I now develop classroom technology and study how to design effective pedagogy for novel educational environments. This shift began as I became involved in educational outreach activities in our department. I found the area fascinating, challenging, and rewarding, and have managed to attract a strong group of students to work with. Four years ago, I spent a sabbatical year with the Learning Sciences and Technology group at Microsoft Research, which has led to a very successful collaborative relationship. The flexibility given by the University of Washington, and by my own department, has been very important in allowing me to pursue this non-traditional path. Today I will be talking about aspects of educational technology. To illustrate some general principles, I will discuss three particular areas I have worked in at the University of Washington.

Key points that I want to get across are that there is tremendous potential for applying new technology to support higher education – as long as instructors define and pursue pedagogical goals that are an appropriate match for the technology. Applying technology to the classroom in a way that actually enhances learning is neither easy, nor cheap, and there is still substantial work to be done in developing teaching methodologies in concert with the underlying technology.

*Tutored Video Instruction* is a novel mechanism for taking advantage of archived educational materials in the classroom. The idea is to facilitate discussion around pre-recorded materials – so students can reach an understanding of classroom content with the help of their peers and a tutor. This method of instruction was developed at Stanford in the 1970's by Jim Gibbons and his colleagues. They demonstrated very impressive results in terms of learning outcomes by students at remote sites. Our tutored video instruction project at the UW made our introductory computing courses available at community colleges. We wanted students who took the courses at the community colleges to be prepared for follow-on courses when they transferred to a four-year institution. Basing the courses on our pre-recorded materials ensured that the coverage was the same as at UW, and the tutored video model allowed community college instructors to take advantage of the face-to-face interaction. We ran the program for several years and, I will admit, there were serious challenges and missteps, although on balance there were some very positive outcomes. One in particular was the evolving relationship that the Community College instructors had with the archived materials, integrating the content into their teaching repertoire. The technology for capture, distribution, and replay of course materials has improved greatly from the days when Jim Gibbons did his initial work, enabling Tutored Video Instruction as well as other initiatives to spread the benefits of education in a variety of contexts. A second project, which is also based on combining facilitated instruction with archived educational materials, is the Digital Study Hall project, being directed by Professor Randy Wang of Princeton University. The Digital Study Hall aims to improve elementary school education in rural India by deploying low-cost digital technology to show pre-recorded educational content, supported by a classroom instructor. One of the brilliant ideas in his project is the model of making it possible for people worldwide to contribute content – such as math lessons in Hindi – which are then used by village school teachers. This model of developing a technology around community-based construction of educational resources is powerful, and has broad applications. The reason that Tutored Video Instruction has tremendous

potential going forward lies in the way it leverages both technology advances and traditional face-to-face interaction.

Another idea that I would like to highlight is *distance learning*. I have worked with distance learning through my department's Professional Master's Program. Some of our courses are offered through site-to-site Internet conferencing. Over the ten-year history of the program, we have used a number of different technologies. Currently, we are using ConferenceXP, which was developed at Microsoft Research. There are tradeoffs between distance and face-to-face instruction, and I don't want to downplay the technical and pedagogical expertise necessary to foster high quality real time interaction. However, Internet technology enables some very significant improvements that deserve mentioning. Our most interesting successes have been in delivering four-way courses taught between UW, UC Berkeley, UC San Diego, and Microsoft. These were interdisciplinary courses in Information Technology & Public Policy, and in Homeland Security, that brought together expertise not available on any single campus. The instructors included computer scientists from UW and UCSD, and a lawyer and an economist from UC Berkeley. The technology enabled real time interaction between sites – going a step further than just sharing of lecture content. One of the exciting opportunities of distance education is the possibility of creating experiences that wouldn't otherwise be possible.

Finally, my current project aims to enhance traditional classroom instruction through the use of student devices. The vision is a classroom where students have networked devices – laptops, personal digital assistants, tablets, or even cell phones, which interact with the instructor's device to create a learning environment rich in both spoken and electronic interaction. The underlying technology is widely available and there are a variety of approaches to getting computational devices into the hands of students. The motivation behind augmenting the classroom with student devices is to achieve specific educational goals. These can include active learning, classroom assessment, and integration

of student work into the classroom discussion. There are many educators and researchers pursuing projects based on such networked classroom infrastructures. One major approach is classroom response systems which have a growing record of documented success in terms of learning outcomes. Notable uses of classroom response systems have been in physics and astronomy, where a pedagogy of *peer instruction* has been developed around students working cooperatively and using a response system so that group responses can be compared and evaluated.

The project at the University of Washington that I am running is the Classroom Presenter project. Classroom Presenter is a Tablet PC based classroom interaction system, where the instructor writes on electronic slides with digital ink and the slides are shared with the student devices. The basic structure of a class session includes activities, where students write their answers on slides, and send them via wireless back to the instructor. The instructor then selectively shows student work anonymously on a public display. This turns out to be very powerful. It greatly increases contributions by students – especially from quieter students who have difficulty participating otherwise. We have observed many different instructor-specific and subject-specific instructional strategies being implemented with the help of the technology – such as displaying answers from all students to demonstrate that they all have valid ideas, or analyzing particular contributions to be able to address specific key points and misconceptions. I have found it far more powerful to use slide contributions by students in order to make individual points than to rely on prepared examples. Designing a class for student interaction causes a fundamental shift in how the class preparation is thought about – a shift from the traditional model resembling the writing of a speech to a model that starts with identifying the learning goals and desired outcomes, then thinking about how to assess such outcomes, and finally connecting those with the course content.

To summarize, there are many opportunities to deploy technology to improve higher education. This includes capturing and reusing educational content to broaden access, connecting people across distances to create opportunities that don't exist locally, and using technology in the classroom to implement strategies that improve student learning. Technology and pedagogy for all of these is still under development – and we are in a period where we have the opportunity for experimentation and discovery. From a personal point of view, the most rewarding part of working in this area has been seeing how colleagues at the University of Washington and at other institutions have used technology in novel and unexpected ways to enhance student learning.

I thank you all for this opportunity to express my views to the Commission on the Future of Higher Education.