Research In Educational Technology: Expanding Possibilities
Richard Anderson
Department of Computer Science and Engineering
University of Washington

July 1, 2008
IUCEE: Research in Educational Technology

Research in Educational Technology

- How can computing technology enhance education?
  - Focus on classroom instruction

- Challenges:
  - Extending reach of education
  - Increasing interaction
  - Addressing problems of scale
  - Facilitating expression of ideas

Past and Current Research Projects

Video conferenced distance education
UW PMP
DISC
Conference@P
Center for Collaborative Technologies

Presentation systems
Classroom interaction systems
Tutored Video Instruction

Classroom Presenter 2.0
Classroom Presenter 3.0

Structured interaction
Classroom Feedback System
CUTs for CS1
Structured interaction

Presentations (SIP)
Student submissions with CP

Digital StudyHall

Research Approach

- Deployment driven
  - Classroom use
  - Technology development and promotion

- Goals and success criteria
  - Adoption of technology and methodology
  - Influence educational practice

- This is a model that has been working for us
  - Target specific deployments that are innovative in some dimensions

Today’s Talk

- Significant point of time for the project
  - Substantial number of completed projects
  - Formation of Center for Collaborative Technologies
  - Deployment of Classroom Presenter 3.0
  - Opportunity to develop classroom technologies that will have a broad impact

- Summary of educational technology projects
  - Lessons learned and remaining challenges

- Future projects

Video Conferenced Teaching

- Multi-site internet based audio-video conferencing
- UW PMP Program
  - Site-to-site courses between UW and Microsoft since Winter 1997
  - Master’s level courses
  - Goal: interaction across sites
    - Approximate single classroom
    - Various technologies have been used since the program was introduced
Video conferencing in the PMP

  - Polycom + Netmeeting for PPT and SmartBoard
- MSR DISC Project
  - Target: UW, CMU, UCB, Brown graduate class
  - Spring 2002
- MSR ConferenceXP
  - Since Spring 2003
    - UW, MSR, UCB, UCSD
    - Ed Lazowska, Steve Mauer

DISC (PMP spring 2002)

- What went wrong
  - Technology and systems failures
  - High cost of interruptions
  - Loss of trust
  - Room configuration issues
  - Lack of control of lecture room
  - Production quality
- Meta lesson
  - Learn more from failures than from successes

How to Fail at VideoConferenced Teaching
  - Microsoft Faculty Summit 2002
  - Anderson & Beavers

ConferenceXP

- Target: High bandwidth internet video conferencing
- Technology: Multicast networking, Internet2
- Vision: Single machine deployment, ease of use
- Designed as extensible platform
  - Integration of other information channels
    - Slides and Ink
  - Source released by MSR as shared source
- Production use in UW PMP since Spring 2003

Center for Collaborative Technologies at University of Washington

- UW center funded for continued work on ConferenceXP Platform
  - http://cct.cs.washington.edu
- Extend functionality of ConferenceXP
  - Diagnostics, Security, Remote management, HDTV integration...
- Build community of users and developers
- Deploy ConferenceXP in new scenarios
  - international education
  - Developing world

Success in distance classes

- Goals
  - Real time interaction between sites
  - High quality video
- Challenges
  - High bandwidth connections
  - Classroom Audio
  - Establishing a pattern of interaction
Hardware Multicast

- Technology bet (2001)
  - Multicast networking to support multisite courses
  - Substantial bandwidth savings
  - Multicast not uniformly supported

Dealing with multicast problems

- Reflector service
  - Plug in unicast to replace multicast
- Used as backup in our courses
- Solution when connecting to networks without multicast

Going International

- March 29, 2008, LACCIR Meeting
  - Latin American and Caribbean Collaboration for ICT Research
- Seattle and University of Chile, Santiago, Chile
- Seminar presentation
- CXP Unicast reflector

Masters class, UW - Pakistan

- Masters class
  - University of Washington
  - Lahore University of Management Science
  - Microsoft
- Computing for the Developing world

Technical Challenges

- Ensuring adequate bandwidth
  - Limited bandwidth to Pakistan
- Reliability
- Multicast
- Ensuring this did not compromise UW-MS class
- Limited time to prepare

Fred’s whiteboard
Use of Classroom Presenter

- Tablet PC based presentation and classroom interaction system
- Ink based presentation
- Classroom Activities

Classroom Activities

- Working with archived lectures
- Large library of recorded lectures available
  - Autumn 2006 Algorithms class recorded with close talking microphone
- Lecture indexing – support text search of speech (and slides and ink)
  - Language modeling necessary (train on algorithms or CS content)
- Lecture summarization
  - Classify lecture episodes
  - Support for lecture browsing
  - Feedback to the instructor
- Lightweight lecture capture
Classroom Presenter

- Support electronic slides and digital ink
- Initially developed for whiteboard integration of DISC
  - “PowerPoint sucks the life out of a lecture”, EDL
- Tablet PC application
  - Digital ink overlay on slide images
  - Feature set aimed at lecture presentation

Ink based presentation

- Tablet PC Inking on images
- Simple pen based controls
- Whiteboard, slide extension
- Multiple views – instructor/display
  - [dual monitor]
- Multiple slides decks with filmstrip navigation
- Instructor notes

Ink usage

Classroom Presenter Deployments

- Adoption in wide range of subjects and institutions
- Many of the key ideas have been generated by users
- Emphasis on simplicity of UI and application

Ink Based Presentation

- Challenge in developing UI to support presentation
  - Low attention UI
  - Introduce a richer set of operations without compromising usability
- Inking behavior very complicated
  - Post processing instructor ink
    - Lecture summaries and visualization

Tablet PC Project: Analysis of Handwritten Notes

- Note taking
  - Many applications exist for taking notes, but the real value of TPC notes (over paper) is being able to work with them digitally
  - Notes vary greatly in structure and are often messy
  - Search: Find “dynamic programming”
  - Type search: Find all phone numbers
  - Classification: Find all pseudocode
Classroom Interaction Systems

• Integration of electronic devices into the classroom to support instruction
• General motivation is to involve students in ways that achieve specific pedagogical goals
  – E.g., Classroom networks have been demonstrated be very effective for science instruction

UW CSE Work on Classroom Interaction Systems

• Tutored Video Instruction
  – Activities to support the facilitator
  – Classroom Assessment Techniques (Angelo and Cross)
• Classroom Feedback System
  – Student response system associated with lecture slides
• Structured Interaction Systems
  – Steve Wolfman’s thesis
  – Rich activity model built into slides

Student Submissions

• Simple model for activity taking advantage of digital ink
• Students write answers on slides, send them to the instructor
• Instructor previews results and selects slides to display to the class

Activity Examples

Find a topological order for the following graph

Find a minimum value out

Determine the LCS of the following strings

Activity Examples

Problems Reduction Examples

Draw a picture of a tablet PC

The travels of a biological system
Deployments
• Algorithms, Digital Design, Software Engineering, Data Structures, Environmental Science at UW
• Outside UW: Physics, Calculus, Ethics, Biology, Electrical Engineering, Introductory Programming, ...
• Used at all levels
  – High School, Community College, University

Classroom goals
• Active Learning
  • Encourage students to contribute in multiple ways
  • Promote engagement in the class
    – Interest
    – Alertness
  • Demonstrate that all students have important opinions
  • Peer interaction
• Feedback – classroom assessment
• Collection of ideas
  – Collective brainstorm
• Student generation of examples
• Discovery of a pedagogical point
• Gain understanding of an example
• Show misconceptions

Impact
• Instructors successful at achieving classroom goals
• Significant participation by students
• Change in classroom dynamics
• Negative: deployment overhead

Tutored Video Instruction
• Video recorded lectures shown with facilitator
  – Original model: lectures stopped by students for discussion
  – Peer tutors
• Developed by Jim Gibbons at Stanford University
• Positive results reported in Science [1977]

UW TVI Projects
• Introductory programming
  – Address community college articulation
  – Experiment with alternate approaches to introductory computing instruction
• UW – Beihang Algorithms course
  – Offering of CSE 421 in China
• Digital StudyHall
  – Primary education in rural India

UW – Community College
• Lectures recorded from UW Intro Class
• Shown at CCs with local instructors as facilitators
• Project lasted 3 years, involving 9 CCs
• Phase I
  – Materials from live lecture, centralized grading, management from UW
• Phase II
  – Studio created materials, CC grading

Classroom goals
• Active Learning
  • Encourage students to contribute in multiple ways
  • Promote engagement in the class
    – Interest
    – Alertness
  • Demonstrate that all students have important opinions
  • Peer interaction
• Feedback – classroom assessment
• Collection of ideas
  – Collective brainstorm
• Student generation of examples
• Discovery of a pedagogical point
• Gain understanding of an example
• Show misconceptions

Impact
• Instructors successful at achieving classroom goals
• Significant participation by students
• Change in classroom dynamics
• Negative: deployment overhead

Tutored Video Instruction
• Video recorded lectures shown with facilitator
  – Original model: lectures stopped by students for discussion
  – Peer tutors
• Developed by Jim Gibbons at Stanford University
• Positive results reported in Science [1977]

UW TVI Projects
• Introductory programming
  – Address community college articulation
  – Experiment with alternate approaches to introductory computing instruction
• UW – Beihang Algorithms course
  – Offering of CSE 421 in China
• Digital StudyHall
  – Primary education in rural India

UW – Community College
• Lectures recorded from UW Intro Class
• Shown at CCs with local instructors as facilitators
• Project lasted 3 years, involving 9 CCs
• Phase I
  – Materials from live lecture, centralized grading, management from UW
• Phase II
  – Studio created materials, CC grading
Lessons Learned

- Results were mixed
- Complicated institutional relationships
  - CC students concerned about competition with UW students
- Facilitation model
  - Did not achieve peer facilitation
    - Co-teaching a more accurate description
    - Facilitators wanted external support (e.g., classroom activities)
- Program helped with instructor development

Results

- Offering successful
  - Technology, institutional relationship
- Cross-cultural issues
  - English language materials were comprehensible
  - Classroom discussion primarily in Chinese
- Facilitation model
  - Significant support for facilitators
  - Classroom activities successful (and popular)
  - Facilitators innovative and reproduced some of the instruction
  - Interactive and informal classroom atmosphere

What we’ve learned from all of this

- Value of electronic materials in the process of classroom instruction
- Tools for teaching
  - Teacher and students drive the process
  - Flexible and unpredictable use
- Structured Interaction model
- Broader context – interplay of technology and other issues

UW-Beihang CSE 421

- Materials captured from live classes
  - Slides, talking head, digital ink
- Classroom Technology
  - Students used Tablet PCs to participate in classroom activities
  - Tablets PCs used both at Beihang and UW

Digital StudyHall

- Affiliated Project
  - Randy Wang, Paul Javid (MSRI, Bangalore)
  - Richard Anderson, Tom Anderson (UW)
- Tutored Video Instruction for primary education in rural India
- YouTube + Netflix

Deployment Driven Research

- Development and deployment of educational technology
- Internal
  - Working with our own classes
  - Opportunity to innovate
  - Pressure to make things work
- External
  - Broad range of ideas
  - User suggestions
  - Feedback on ideas
Fan mail

To: Richard Anderson
Subject: UW CSE Web: Classroom Presenter FAQs

Dear Mr Anderson,

I am Edy from Jakarta, Indonesia. What a great software I found, made by UW CSE.

To: Richard Anderson
Subject: UW CSE Web: UW Classroom Presenter

May I take a moment to say, once again, THANKS for creating CP! I've used it during a conference presentation and in all but one of my classes this year.

To: Richard Anderson
Subject: CSE Home Page: Classroom Presenter FAQs

Dear Dr. Anderson,

So, I think you can say I'm trying out CP for the first time. I really thank you for your enormous effort to provide such an excellent tool.

To: Richard Anderson
Subject: Re: TP Mode

Richard,

Thanks again for your support of this great product. Seriously, I would not be lecturing with my tablet pc without it. Powerpoint was way too restrictive and made me REALLY nervous.

July 1, 2008 49IUCEE:
Research in Educational Technology

Classroom Technology Challenges

- Make it universal
- Deepen level of interaction with materials
- Expand the reach

Broader Access

- Critique of Classroom Presenter
  - . . . but students don't have Tablet PCs
  - High overhead in deployment
  - Many different costs
- Sustainable deployment
  - Student owned devices
  - Heterogeneous deployment of devices
  - Value to all participants

The next steps

- Electronic, slide based lecture supporting flexible instructor control
- Extend device and interaction models
- Wide range of interaction models available
  - Polling, Group Scribbles, Multipoint, shared whiteboard, student submissions
- Challenge
  - Maintain focus and simplicity

Richer content support for slide based lectures

- Slide model: static content or build slide animations
- Challenge: provide a richer model of content for dynamic presentations
  - Particular domain of interest: mathematical content
- Starting points
  - Instructor notes
  - Structured Interaction Presentations (SIP) [Wolfman]
  - Geometrical structure for slides

Facilitation for Tutored Video Instruction

- Teaching with recorded materials
  - Peer discussion vs. co-teaching
- Regular interruptions for active learning
- Beihang class
  - Facilitators made substantial use of Classroom Presenter
  - Activity structure was successful
- Projects
  - Develop integrated TVI replay, presentation and classroom interaction tools
  - Refine methodology for combining active learning with TVI
  - Replay tools for DSH scenarios
Classroom Accessibility

- Opportunities in electronic classroom for greater accessibility
- Classroom capture and archiving
- Real time interpretation
  - Captioning/Screen reading
- Input
  - Instant messaging, shared whiteboard, custom input facilities
- Collaborative work with Richard Ladner

Classroom Presenter 3.1

- Richer Feature Set
  - Display Control
  - Classroom Interaction
    - Quick Poll
    - Expanded interaction models
    - New classroom activities
    - Additional source content
- Performance
  - Scalability in wireless classroom

Center for Collaborative Technologies

- Development of ConferenceXP Platform
- Establish as a shared source project
- System enhancements
  - Multicast diagnostics
  - Security
- Deployments
  - Collaboration with Microsoft sponsored Latin America Virtual Institute
  - UW Professional Master’s Program

Domains of Special Interest

- Higher Education
- International Courses
- Developing World
- Global Health

International Education

- Multi-site classes with ConferenceXP
- Challenges
  - Networking issues (firewall, multicast)
  - Identifying cases where interactivity is needed
  - Time zones
    - West Coast US (6:00 pm) & China (9:00 am)
- Short term
  - Pilot tests with Chinese Universities
  - Latin America Virtual Institute
  - International guest lectures for UW CSE PMP Class (spring)
Developing World

- Tremendous challenges faced in education in the developing world
- Technology supported instruction that is cost-realistic and sustainable
- Digital StudyHall
  - India, Bangladesh, Eritrea, ...
- Interactive, Facilitated Video Instruction
- Low cost multi-person interaction
  - E.g., Multimouse
- Deployment issues
  - Lack of power, network connectivity

Global Health

- Strong regional opportunity
- Distance education to support medical education
- Alternate models of video based instruction

For more information

- Richard Anderson
  - anderson@cs.washington.edu
- Classroom Presenter
- Center for Collaborative Technologies at UW
  - http://cct.cs.washington.edu/
- Digital StudyHall
  - http://dsh.cs.washington.edu/
- Other contacts
  - CCT: Fred Vidon (fred@cs.washington.edu)
  - Digital StudyHall: Paul Javid (pjavid@cs.washington.edu), Tom Anderson (tom@cs.washington.edu)
  - Classroom Accessibility: Richard Ladner (ladner@cs.washington.edu)

Acknowledgements

- Support from Microsoft Research, National Science Foundation, HP, Ford, UW CSE
- Jay Beavers, Jane Prey, Randy Hinrichs, Chris Moffatt, Jason Van Eaton, Paul Oka, Steve Wolfman, Ken Yasuhara, Kate Diebel, Ruth Anderson, Craig Prince, Valentin Razmov, Natalie Linneli, Krista Davis, Jonathon Su, Sara Su, Peter Davis, Tammy VanDeGrift, Joe Tront, Alon Halevy, Gaetano Borriello, Ed Lazowska, Hal Perkins, Susan Eggers, Fred Vidon, Rod Prieto, Oliver Chung, Crystal Hoyer, Beth Simon, Eitan Feinberg, Julia Schwartz, Jim Fridley, Tom Hinkley, Ning Li, Jing Li, Luo Jie, Jiangfeng Chen