



Tablet PC's and the Electronic Classroom

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Background

- Department of Computer Science and Engineering, University of Washington
 - Since 1986
- Experience
 - Phd., Stanford University, 1985
 - Post doc, Math Sciences Research Institute, Berkeley
 - Visiting Professors, IISc, Bangalore, 1993
 - Visiting Scientist, MSR, 2001
- Research Interests
 - Educational Technology, Pen Based Computing, Computing for the Developing World



Integration of Student Devices in the Electronic Classroom




What will the classroom look like . . .


- If all students have computational devices
 - Laptops, Tablets, Ultra light tablets, PDAs, Smart Phones, Gameboys . . .
- If the devices are all connected
- If the devices are all integrated into classroom instruction

Wide range of potential classroom applications

- Presentation
- Demonstration
- Simulation
- Accessing external resources
- Note taking
- Feedback
- Active learning
- Peer communication



The Slide Based Lecture



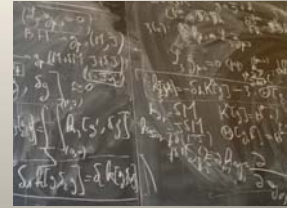
- Widely used in higher education
 - But often criticized
- What are the good points?
 - Provides structure for class
 - Sharing materials and persistent across course offerings
 - High quality diagrams and pictures
 - Mediating artifact for discussion

What do good teachers do with PowerPoint?

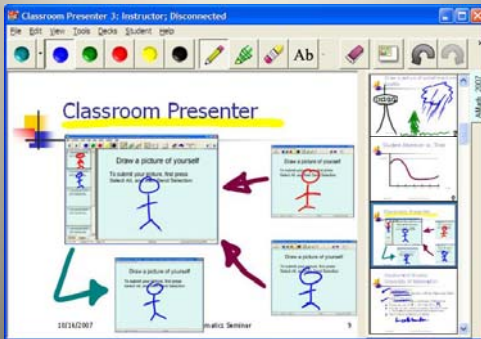
- Use technology to leverage teaching skills
- Maintain interaction with audience
- Adjust presentation based on audience feedback
- Use other mechanisms for altering displayed material

Ink in the Classroom

- Flexibility to create content
 - Rich expression
 - Symbolic and diagrammatic languages
 - Show process
- Classroom Presenter
 - Integrate digital ink and electronic slides on Tablet PC



Classroom Presenter



“Typical ink usage”

Memory

0001	0014	PC	31x36
0002		IR	3001 5002
0003			0000
0004		Accum	000F
0001	had 001		+ 0005
0002	add 002		0014
0003			
→		4000	store 000

Concerns

- 1) No Physical Copy
- 2) Cost - (expense)
- 3) Breaks / Lost
- 4) Learning Curve
- 5) Distraction due to UI
- 6) Sunlight - hard to read screen
- 7) UI Difficulties - small screen
- 8) Loss of flexibility to input
- 9) Symbolic systems issues
- 10) Time saving + Data

Mathematical expressions:

$$(\lambda x \times \lambda y) \rightarrow (\lambda y y) (\lambda z z) \rightarrow$$

$$((\lambda y y) (\lambda z z)) (\lambda z z) \rightarrow$$

$$((\lambda y y) (\lambda z z)) (\lambda z z) \rightarrow$$

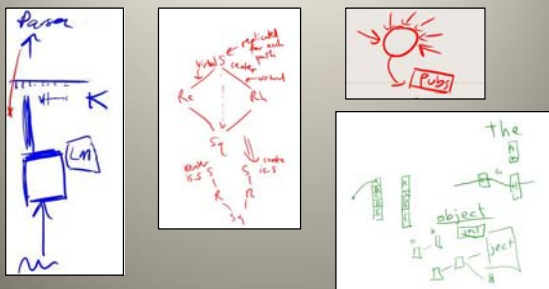
$$(\lambda z z) (\lambda z z) \rightarrow$$

$$(\lambda x \times \lambda y) \rightarrow (\lambda z z) \rightarrow$$

$$(\lambda z z) (\lambda z z) \rightarrow$$

Mackerel Economics

Diagrammatic Ink



Activity Based Lesson

- Active Learning
 - Student based activities integrated into lesson
 - Supported by many different educational theories
 - Group work, feedback, reinforcement, peer learning, constructivism, engagement

Classroom Presenter

The diagram illustrates the Classroom Presenter architecture. It features an 'Instructor' window at the top left, a 'Public Display' window at the bottom left, and two 'Student' windows on the right. Each window displays a 'Draw a picture of yourself' task. Orange arrows indicate the flow of information: from the Instructor to the Public Display, from the Public Display to the Student windows, and from the Student windows back to the Instructor.

Activity Examples

Four examples of student work on Classroom Presenter slides:

- Find a topological order for the following graph:** A directed graph with nodes 1-7. Handwritten notes: "No Solution" and "has a cycle".
- Find a minimum value cut:** A flow network diagram. A box shows the value "17".
- Determine the LCS of the following strings:** BARTHOLEMEWSIMPSON, KRUSTYTHECLOWN, RTHOWN. Handwritten lines connect matching characters.
- How good is this algorithm?:** A question about the feasibility of computing the LCS of two strings of length 100,000. Handwritten notes: "No", $10^5 \times 10^5 = 10^{10}$ nodes to visit, and "need to store all nodes in memory - compute each".

Classroom goals (atmosphere)

- Encourage students to contribute in multiple ways
- Promote engagement in the class
 - Interest
 - Alertness
- Demonstrate that all students have important opinions
- Peer interaction

Classroom Goals (specific activities)

- Feedback – classroom assessment
- Collection of ideas
 - Collective brainstorm
- Student generation of examples
- Discovery of a pedagogical point
- Gain understanding of an example
- Show misconceptions

History of Classroom Presenter

- Initially designed as presentation system for distributed classroom
 - Ink and slides for flexibility in distance learning presentation
- Stand alone presentations
- Integration with student note taking
- Active learning with annotations from students
- 2001-2002 Project started at MSR
- Code released to UW to allow continuation of project
 - Integration with ConferenceXP
 - MSR license
 - Multicast networking
- 2006, CP3 released
 - Improved network communication
 - BSD Open source license

Classroom Presenter as a distributed application

- Designed as distributed application for distance learning
- Enables many scenarios
 - Mobility
 - Walking and talking
 - Sharing materials with students
 - Note taking
 - Classroom interaction
 - Student submissions

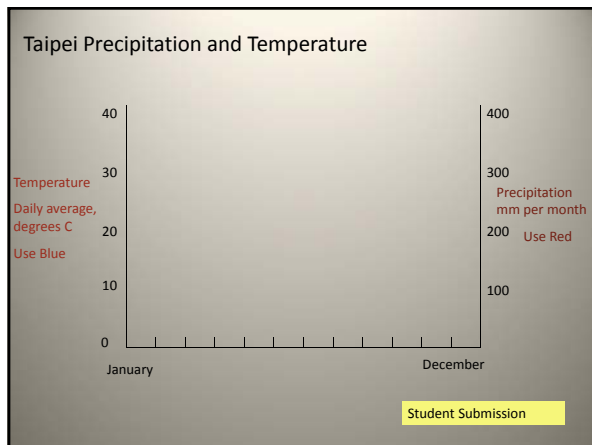
The diagram shows a group of stylized human figures interacting with a presentation slide. The slide is titled 'Variable' and has three bullet points: 'memory', 'name', and 'type'. A small box labeled 'dead' is also visible.

Basic Usage, Higher Education

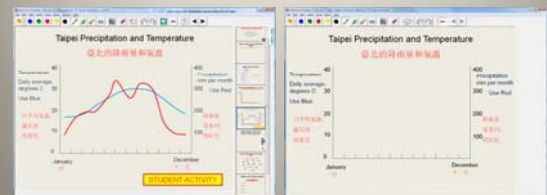
- Initially targeting Computer Science Classes
- Picked up by a wide faculty in a wide range of disciplines

Discussion Artifact

- Use student generated example to explore different aspects of a topic
- Assess overall understanding
- Diagnose misconceptions



Aside: Instructor Notes



Text that only appear on the instructor's screen

Discovery Activity

- Have students derive a concept from an example

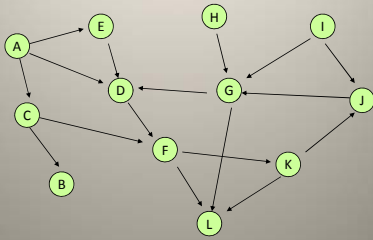
Topological Sort

- Given a set of tasks with precedence constraints, find a linear order of the tasks



- Label vertices with integers $1, 2, \dots, n$
 - If v precedes w , then $l(v) < l(w)$

Find a topological order for the following graph



Collective Brainstorm

- Generate student ideas for discussion
- Build a list of ideas
- Analyze and evaluate responses

Special problem: Large Size

- List at least three problems trees must face (& solve) because of their large sizes.

- 1.
- 2.
- 3.



Problem Introduction

- Have students explore an instance of a problem before topic is introduced

Determine the LCS of the following strings

BARTHOLEMEWSIMPSON

KRUSTYTHECLOWN

Submissions

Determine the LCS of the following strings

BARTHOLEMEWSIMPSON

KRUSTYTHECLOWN

Determine the LCS of the following strings

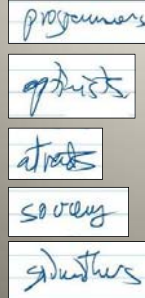
BARTHOLEMEWSIMPSON

KRUSTYTHECLOWN

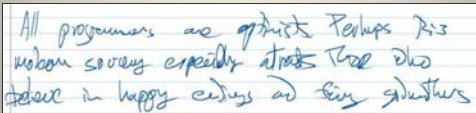
Challenge problems

- Competition in getting solutions
- Simultaneous work
- Submission and discussion

Handwriting Recognition: Identify the following words



Recognition results



Converted text:
All propounders are oppugns), Perhaps 2-3 motion sorcery especially attracts Those oho believe in happy adios of Sais godmothers

Ink from note:
optimists

Alternative:
oppugns),
optimists,
optimists,
oppugns),
opuses),
optimist.,
optimists

Example Submissions

Chief Reasons for Software Project Failures: Question

- What might be the main reasons behind such a large percentage of software project failures?
- State one reason that you and the person next to you think is prevalent.

CA SCHEDULE =ING

Testing

- Testing helps to establish if the program works because we don't know how it really is edge case.
- Testing begins (when?) when design begins because it is easier to correct flaws earlier.

Activity: Can any sequential system be represented with a state diagram?

Shift register

- input/output stream on transition area
- initial state values within state nodes

ZIG-ZAG

Show the ZIG-ZAG transformation to bring X to the root

Example Submissions

Draw a picture of a Tablet PC

- Let's get this done!

- There, done. You crazy fellow.

Find a topological order for the following graph

Determine the LCS of the following strings

BARTHOLEMESWIMPSON
KRUSTYTHECLOWN
RTHOWN

How good is this algorithm?

- Is it feasible to compute the LCS of two strings of length 100,000 on a standard desktop PC? Why or why not.

$10^5 \times 10^5 = 10^{10}$
No $100,000 \times 100,000$ nodes to visit
need to store all nodes to memory = compute cost.
Not feasible for this alg.

Interesting Case Studies


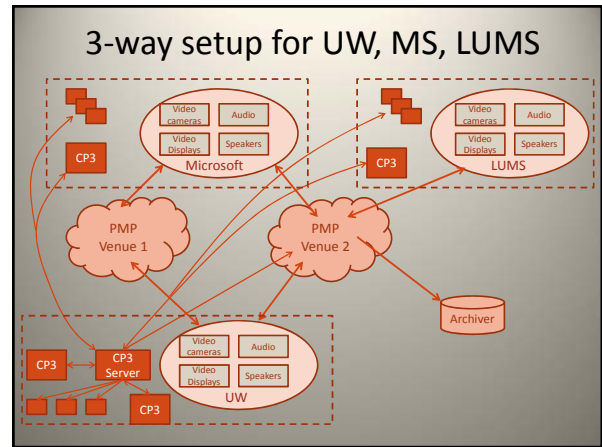
- Synchronous Distance Education
- Tutored Video Instruction
- Elementary School

ConferenceXP Project

- High quality, low latency video to support interactive classes
- High bandwidth internet video conferencing
 - Internet2
 - Multicast
- Collaboration between UW and MSR
- Distance learning support for UW Professional Master's Program
 - Distance courses between UW and Microsoft


Masters class, UW - Pakistan

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

Classroom Activities

SMS Applications (Homework 3)




Country: Pakistan, Country: Guatemala
 Domain: Cellular, Problem: Domain, Domain: Cellular, Problem: Cellular, Problem: Cellular

What could go wrong?

- What are the potential difficulties with a large scale PDA based survey?
- Power supply
- Usability - training may be needed
- Bias toward the technology (too sophisticated)
- Crash can cause data loss
- Language - is local language available?
- Stealing of the device
- Maintenance - SW update and HW repair

How has cell phone usage increased over time?



Identify three potential Kiosk applications

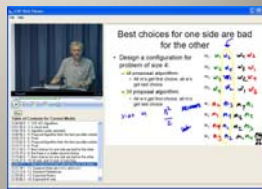
Application	Potential	Social Benefit
Remittance	high	med
Microfinance	med	high
Government services	low	med

Tutored Video Instruction

- Recorded lecture materials
 - Generally based on live classes
- Class model
 - Lecture playback alternating with facilitator led discussion
 - Facilitation models
 - Gibbons: Peer instruction
 - Active facilitation

UW-Beihang, Algorithms course

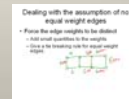
- Offer course based on UW course in Beijing
- UW Instructor could not give the course in Beijing
- Scheduling prevented live course offering
 - 1:30 pm Seattle, 4:30 am Beijing
 - Materials captured from live classes
- Tutored Video Instruction
 - Slides, talking head, digital ink



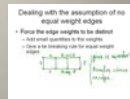
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Facilitation

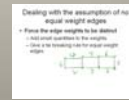
- Support provided for facilitators
 - Lecture notes
 - Activities
- Facilitators invested a larger effort in preparation
 - Studying videos
 - Planning how to cover content
- Active facilitation
 - Worked through lecture examples
 - Led activities
 - Asked questions to students
- Example: facilitators working through example from lecture slides



Instructor



Facilitator A



Facilitator B



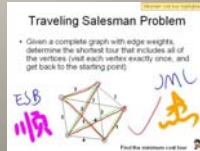
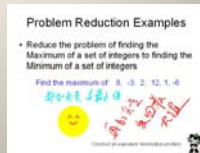
Facilitator C

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Classroom Activities

- Tablet PC supported activities
 - Student submission model
 - Used for every lecture
- Technology generally successful
- Considered very positive by students
 - High rate of participation
- Provided a structure for active learning



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Classroom Environment

- Contrast to traditional large lecture class
- Highly interactive class
 - Interaction episodes measured by observation logs and videos of Beihang classes
 - Average of 13 interaction episodes per class, 10 with students speaking
 - UW class averaged about 20 interaction episodes per equivalent length of time
 - Beihang episodes averaged a greater number of rounds of communication
- Class atmosphere was informal

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Results

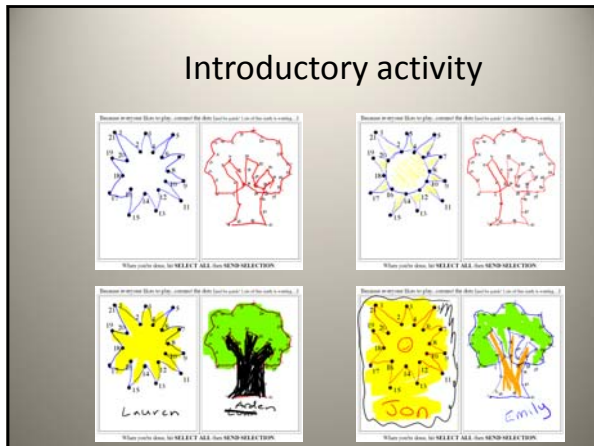
- Offering successful
 - Technology, institutional relationship
- Cross-cultural issues
 - English language materials were comprehensible
 - Classroom discussion primarily in Chinese
- Facilitation model
 - Significant support for facilitators
 - Classroom activities successful (and popular)
 - Facilitators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

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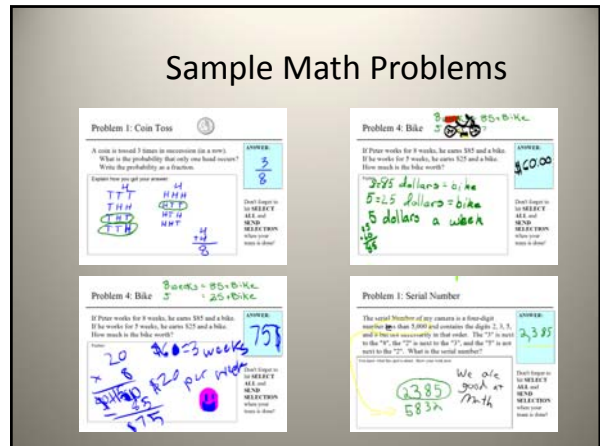
Elementary School

- Classroom visits with Tablet PCs
- Seattle Public School
 - 4th grad
 - After school math club
- Massachusetts Public Schools
 - Kimberle Koile
 - Classroom Learning Partner

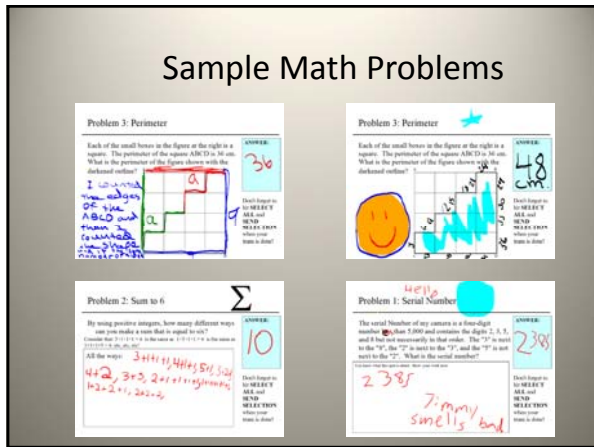
Introductory activity



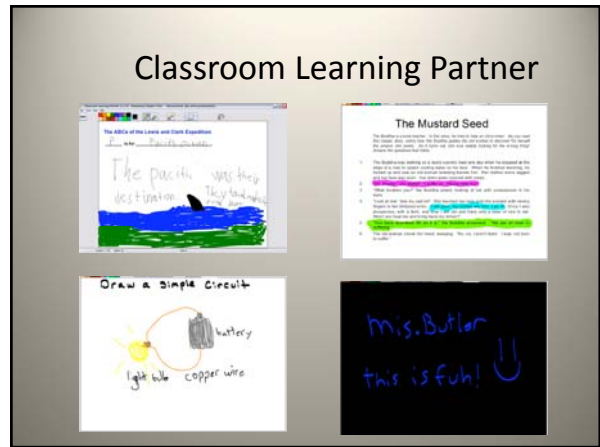
Sample Math Problems



Sample Math Problems



Classroom Learning Partner



School Summary

- Activity model worked very well
- Positive Aspects
 - Student engagement
 - Showing work on public display
 - Visible process
- Negatives
 - Student distraction, excessive drawing
 - Feature request – limit access to highlighter
- Students master technology instantly
 - Teachers may take longer
- Fits naturally with elementary school pedagogy
- Technology must be robust and easy to use

Classroom Presenter: Going Forward

- Distribution Model – Academic Freeware
- Establish Electronic Classroom Initiative
 - Consortium of industrial and educational institutions
 - Advisory board
- Classroom Presenter 4
 - Improve performance (scale to large classes)
 - Cross device compatibility
 - Platform for others to extend (open source)
 - Expand to K-12

For more information

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Microsoft
Research

