INTEGRATING DIVERSE STUDENT DEVICES INTO THE DIGITAL CLASSROOM

Motivation

Goal: Improve education by integrating computing devices into classroom.

Do in low-cost, sustainable way.

One way, leverage devices students carry!

Before I Begin…

- Who has a laptop or Tablet PC with them?
- Who has a cell phone or PDA with them?

College Students:
- 86.1% Cell Phone
- 12.0% Smart Phone
- 11.9% PDA
- 56.3% Digital Gaming Device
- 73.7% Laptop

Source: The ECAR Study of Undergraduate Students and Information Technology, 2007

My Talk – In Three Parts

- Part I: Background
  - Active Learning
  - Classroom Responses Systems (CRSs)
  - Different CRS activities

- Part II: Systems
  - Tablet PC-based
  - Handhelds

- Part III: Future Work
  - Improve type of exercises on handhelds
  - Integrate diverse handhelds into class

Part I: Background

- Active Learning
- Classroom Responses Systems (CRSs)
- Different CRS activities

Active Learning

- Active Learning = teaching pedagogy were best way to teach students is to have them be active in the learning process
- Abrahamson’s “Socratic teaching” method
- “Constructivism” vs. “Behaviorism”
- Student needs to:
  - Build on existing mental framework
  - Incorporate existing knowledge and ideas

Quantitative Evidence

- Hake’s study
  - 62 physics courses
  - >6000 students
  - Set taught interactively
  - Set taught traditionally (lecture focus)
- Students in interactive courses had learning gains 2 std. dev. greater than traditional courses


Active Learning in the Classroom

- Mazur’s “Peer Instruction”
  - Mechanism for Active Learning
  - Basis for many classroom technologies
- Promotes:
  - Discussing/collaborating between students
  - Integrating student work into lectures


Classroom Network

Classroom Technology

Classroom Response System (CRS): Learning Cycle

Multiple-Choice Example
Multiple-Choice Example 2

What criteria would you use to evaluate these UI choices:
- Ease of use
- Usability attractive
- Originality
- Small user-learning curve

Diagrammatic Example

Diagrammatic Example

Image Example

Brainstorming Example

Systems at Different Scales

Outline 3 systems that represent 3 different scales of biological organization.

Draw an O(n) communication graph

- Support full communication in team of size n
What Activity Types are Best?

- No quantitative studies showing digital ink makes for better activities in CRSs
- Advantages of Digital Ink
  - Strictly more expressive
  - Some activities clearly easier with Digital Ink
  - Instructors like using these types of activities
- Disadvantages of Digital Ink
  - Harder to aggregate/understand

Part II: Systems

- Tablet PC-based
- Handhelds

Tablet PC CRSs

- General Properties:
  - Support many types of exercises
- Examples:
  - Classroom Presenter
  - Ubiquitous Presenter
  - DyKnow
  - GroupScribbles

Classroom Presenter

- Devices:
  - Tablet PC
  - Laptop
- Activities:
  - Whole Slide, Ink/Text
- Features:
  - Anonymous Submissions
  - Push Model
- Limits:
  - Cost

Ubiquitous Presenter

- Devices:
  - Web-browser
- Activities:
  - Whole Slide, Text
  - Multiple-choice
- Features:
  - Same as Classroom Presenter
- Limits:
  - Requires Web Server

DyKnow

- Devices:
  - Tablet PC
  - Laptop
- Activities:
  - Whole Slide, Ink/Text
  - Multiple-choice
- Features:
  - Integrated System
  - Instructor Control
  - Pull Model
- Limits:
  - Cost


GroupScribbles

Devices:
- Tablet PC
- Laptop

Activities:
- Post-it Note, Ink/Text

Features:
- Multi-part Activities
- Multiple Subs.
- Editing/Moving Sub.

Limits:
- Cost


Clickers

Devices:
- Custom

Activities:
- Multiple-choice

Features:
- Small and Affordable
- Scales to 100s

Limits:
- Limited Utility HW
- Used for Wrong Reasons?


Handheld CRSs

General Properties:
- Many types of small devices
- Activities more limited

Examples:
- Clickers
- Classtalk
- Pebbles
- ActiveClass
- PLs TXT UR Thoughts
- Ubiquitous Presenter (Mobile)


Classtalk

Devices:
- PDA
- Calculator (TI-83)

Activities:
- Multiple-choice
- Short Answer
- Numeric

Features:
- Binning (All Responses)

Limits:
- PDA Cost/Popularity


Pebbles

Devices:
- PDA

Activities:
- Multiple-choice
- Question Asking

Features:
- General Framework
- PebblesDraw
- Shared Whiteboard

Limits:
- PDA Cost/Popularity


ActiveClass

Devices:
- PDA

Activities:
- Multiple-choice
- Question Asking

Features:
- Voting on Questions
- Results Always Avail.

Limits:
- PDA Cost/Popularity

**PLS TXT UR Thoughts**

- **Devices:**
  - Cell Phone
- **Activities:**
  - Question Asking
- **Features:**
  - SMS Communication
  - Anonymous
- **Limits:**
  - Recurring SMS Cost
  - SMS Length (160)


**Ubiquitous Presenter (mobile)**

- **Devices:**
  - Cell Phone
- **Activities:**
  - Multiple-choice
  - Short Answer
  - Camera-based
- **Features:**
  - SMS \(\rightarrow\) Abbreviations
  - Anonymous
- **Limits:**
  - Recurring SMS/MMS Cost


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**Summary of All Systems**

<table>
<thead>
<tr>
<th></th>
<th>Digital Ink</th>
<th>Textual</th>
<th>Multiple-choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Slide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-It</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole Slide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>? Asking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Answer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numeric</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table PC
- Tablet PC: Table PC
- Laptop: Table PC
- PDA: Table PC
- Calculator: Table PC
- Phone: Table PC
- Custom: Table PC

Laptop
- Tablet PC: Laptop
- Laptop: Laptop
- PDA: Laptop
- Calculator: Laptop
- Phone: Laptop
- Custom: Laptop

PDA
- Tablet PC: PDA
- Laptop: PDA
- PDA: PDA
- Calculator: PDA
- Phone: PDA
- Custom: PDA

Calculator
- Tablet PC: Calculator
- Laptop: Calculator
- PDA: Calculator
- Calculator: Calculator
- Phone: Calculator
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Phone
- Tablet PC: Phone
- Laptop: Phone
- PDA: Phone
- Calculator: Phone
- Phone: Phone
- Custom: Phone

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**Part III: Future Work**

- Improve type of exercises on handhelds
- Integrate diverse handhelds into class

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**Enabling Adoption?**

- Expressiveness: Digital Ink
- Cost: $\rightarrow$ $$
- Multiple Choice: No

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**Ubiquitous Presenter (mobile)**

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- **Limits:**
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Challenges

- “Increasing Mobile Interaction”
  - Understand types of activities
  - How to do them on mobile devices
- “Using Existing Devices”
  - Dealing with heterogeneous mix of devices

Steps to Tackle Challenges

1. Look at styles of activities supported on different devices esp. what interactions are needed
2. Look at how well each device feature performs on these activity styles
3. Explore techniques for making activity styles feasible on mobile devices and test
4. Develop application that supports multiple device types
5. Develop tool for designing activities to suit multiple devices – design activity once, translate to several devices
6. Develop tool for taking responses of different forms and interpreting/aggregating them

Step 1: Activity Styles Taxonomy

What:
- Activity Patterns:
  - Brecht et al.
  - DiGiano et al.
  - Classroom Presenter observations
  - Other Education Work
- Focus on CRS activities
- Hierarchical Taxonomy
- Goal: Benchmark

How:
- Large Corpus of Activities
- Compile Taxonomy Manually
- Expand as needed

Step 1: Potential Activity Styles

- Locate Item On Image
  - Single/Multiple items?
  - Location?
  - Scale?
  - Boundaries?
- Create a Diagram
  - Elements?
  - Labels?
  - Connectivity?
- Modify/Complete a Diagram
  - Structure?
  - Labels?
- Highlight a Diagram

Step 2: Existing Techniques

What:
- Given device capabilities, quantize performance
- Test feasibility of activity for each device
- Use existing research where avail.
  - Text input speed on different devices
  - Pointing task research
  - Focus on diagrammatic/image responses

How:
- Literature review
- Implement techniques
- Lab studies to test performance on benchmarks

Device Input Capabilities

<table>
<thead>
<tr>
<th>Input Modality (Hardware)</th>
<th>Example Mobile Devices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyboard</td>
<td>Laptop, Tablet PC (hybrid)</td>
</tr>
<tr>
<td>Keypad</td>
<td>Mobile Phone</td>
</tr>
<tr>
<td>Directional Pad (2-way, 4-way, or 8-way)</td>
<td>Mobile Phone, PDA, Gaming Device</td>
</tr>
<tr>
<td>Mouse</td>
<td>Laptop (external)</td>
</tr>
<tr>
<td>Trackball</td>
<td>Laptop (external)</td>
</tr>
<tr>
<td>Touchpad (relative motion only)</td>
<td>Laptop</td>
</tr>
<tr>
<td>Joystick</td>
<td>Gaming Device</td>
</tr>
<tr>
<td>Accelerometer</td>
<td>Mobile Phone, PDA</td>
</tr>
<tr>
<td>Stylus/Pen</td>
<td>Tablet PC, PDA</td>
</tr>
<tr>
<td>Touch-screen</td>
<td>iPhone, Tablet PC (some)</td>
</tr>
<tr>
<td>Camera</td>
<td>Mobile Phone, iPhone</td>
</tr>
</tbody>
</table>
Device Screen Sizes

Physical Screen Width vs. Height

Phones
PDAs
Gaming
UMPCs
Tablets
Laptops

Step 3: New Techniques

What:
• No adequate techniques?
• Try to invent new ones

How:
• Identify gaps from prev. step
• Examples:
  ○ Stylus drawing on small screen w/ large virtual canvas
  ○ Drawing arbitrary regions without stylus
• Test performance using lab tests

Step 3: Example Arbitrary Regions

Rubber-band?

Step 4: Develop Application

What:
• Base on Classroom Presenter
• Requirements:
  ○ Identify device type/capabilities
  ○ Screen size/resolution
  ○ Open platforms? Android?

How:
• Use existing standards:
  ○ Ubiquitous Presenter uses HTML and JavaScript
  ○ Wifi or SMS for networking
• Support for:
  1. Stylus Devices (Tablet PC, PDA, Smart Phone, Nintendo DS)
  2. Touch Screen
  3. Keypad
• Success = deployment & support for devices

Step 5: Instructor Design Tools

What:
• Consider classroom issues with different devices
  ○ Envy
  ○ Equality
  • Given benefits/drawbacks of different modalities,
  • Recommend alternative activity types?
  • Balance activity types given?

How:
• Tool Input
  ○ Instructor activity (PowerPoint?)
  ○ Activity metadata
• Tool Internals
  ○ Determine activity type
  ○ Optimizes interaction for each device in class
• Tool Output
  • Recommendations for activity types
  • Evaluate with user-study of tool

Step 6: Instructor Class Usage

What:
• Use activity metadata
• Use salient regions of responses
• Understand and aggregate results
• Finding common misconceptions

How:
• Unsupervised/semi-supervised clustering
• Evaluation
  ○ Test data from real classes
  ○ Measure success on data
  ○ User-study to observe utility
Step 6: Example Tic-Tac-Toe

```
X  X  O
O  O  X
X  X  O

? = X  X  O
```

Conclusions

- **Two Problems**
  - Increasing Mobile Interaction
  - Using Existing Devices
- **Solution**
  - Activities and devices
  - Tools:
    - Enable multiple devices
    - Help instructor
- **Goal**
  - Make deploying CRSs a reality
  - Improve Education

Questions?