The Classroom Learning Partner
Promoting Meaningful Instructor-Student Interactions in Large Classes

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Overview

• **Problem**
  – Personal interaction impossible in large classes
  – Need to increase interaction for two-way conversation

• **Project Goal**
  – Increase student interaction and learning in large classes by:
    * supporting the use of in-class exercises
    * without overwhelming the instructor
Why in-class exercises?

- **Active learning**
  - students learn better when actively engaged
  - best if engage in higher order thinking tasks such as synthesis, analysis, evaluation

- **Formative assessment**
  - as part of learning experience
  - hands-on activities with immediate feedback
  - instructor and students identify misunderstandings in "real-time"
Classroom Learning Partner combines two learning approaches:

- **Large classes: Personal Response System (PRS)**
  - Wireless polling system; students use transmitter to submit answers to multiple-choice or T/F questions in class
  - Successful in large classrooms
  - *CLP will let instructors use non-multiple-choice exercises*

- **Small classes: Wide variety of in-class exercises**
  - Instructor only has to evaluate small number of answers
  - *CLP will let instructors use wide variety of exercises without being overwhelmed*
How

Start with existing Tablet-PC-based Classroom Presenter system

• Wireless presentation system, instructor slides displayed on large screen and students’ Tablet PCs

• Student anonymous submission of digital ink answers to exercises

How (2)

Extend it to work in large classes

- **Interpret handwritten text**
  - i.e., give it semantics
    

    \[5\text{ number 5}\]

    \[\text{robot}\text{ sequence of characters r o b o t}\]

    \[\begin{array}{c}
    \text{structured object [box+pointer 1 [box+pointer 2 nil]]}
    \end{array}\]

- **Aggregate student answers into equivalence classes**
  - cluster or compare with instructor-provided answer(s)
  - only show instructor small number of representative answers, e.g. 1 per bin
In class

Collect student submissions

Instructor's machine

Student answers

Students' machines

Screen
In class (2)

- Aggregate student answers
- Display results to instructor
Classroom Presenter Screens

**Instructor**

**Student**

---

**Your turn**

- The following expressions evaluate to values of what type?
  
  Q1. `(lambda (a b c) (if (> a 0) (+ b c) (- b c)))`

  Q2. `(lambda (p) (if p "hi" "bye"))`

  Q3. `(* 3.14 (* 2 5))`

---

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student responses for one class
You are now students.
Tablets in the classroom
“Your turn” exercises

Dr. Kimberle Koile
Draw a picture of yourself here:

... and send it to me!
Robot Path Planning

Goal: "Go get me coffee, please."
Goal: "Go get me coffee, please."

1. Draw the path you'd like for the robot to take.

2. What English directions would you give him to get him inside the coffee room? (Assume that a colleague is figuring out coffee acquisition.)
Robot Path Planning

Goal: "Go get me coffee, please."

Assume that you now have this language in which to write directions for the robot:

- `forward x`  (x is # of steps)
- `turn left x` (x is # of degrees)
- `turn right x` (x is # of degrees)
- `no-opening-on-right?:` (true or false)
- `no-opening-on-left?:` (true or false)
- `while x do y:` (repeat action x until y is true)

3. Using this language, write directions to get him to take the first right.
Robot Path Planning

Goal: "Go get me coffee, please."

Assume that you now have this sequence of actions:

1. turn right 90
2. while no-opening-on-left?
   forward 1
3. turn left 90
4. while no-opening-on-right?
   forward 1
5. turn right 90
6. while no-opening-on-left?
   forward 1

Unfortunately, your robot doesn't end up where you expected at ★, but gets stuck at ★. What could be wrong? How could you change the above code to fix it?
What did you notice?

• **Tablet is great for sketching, note-taking**
  – natural, quick interaction

• **Classroom Presenter is great for:**
  – focused, active instruction
  – immediate feedback to students and instructor
  – anonymity
  – questions in different learning categories
    
a la Bloom's Taxonomy:
  * application: apply wayfinding to draw path, give English directions
  * synthesis: write directions in given language
  * analysis: analyze what went wrong
What did you notice?

• **With many questions:**
  – not always obvious whether expected answer is oral or written

• **With many answers, the instructor:**
  – chooses at random
    * hoping to show pedagogically interesting examples
    * can't get sense for whether majority understands
  – or tries to show everyone's answer
    * which slows class down
    * is impossible in large classes
Challenges

```
"Your turn"

The following expressions evaluate to values of what type?

(lambda (a b c) (if (> a 0) (+ b c) (- b c)))
num, num, num → num

(lambda (p) (if p "hi" "bye"))
boolean → string

(* 3.14 (* 2 5))
number
```

**Interpreter:** Illegible handwriting

**Aggregator:** Synonyms, abbreviations, mispeeling
Challenges

**interpreter:** sketching

**aggregator:** similarity measure for complex objects
Challenges

- different kind of challenge
System architecture

1. Slides Saved

2. Slides Retrieved

3. Slides Broadcast

4. Ink Answers Sent

5. Interpreted Ink Answers Sent

6. Interpreted Ink Answers Retrieved

7. Summary Data Stored

8. Summary Data Retrieved

Instructor Slides

Instructor Authoring Tool

Repository

Student Slides

Summary Data

Ink Interpretation

Aggregation

Start here

outside class

inside class

or student machine

retrieve from instructor machine
System architecture

1. Slides Saved
2. Slides Retrieved
3. Slides Broadcast
4. Ink Answers Sent
5. Interpreted Ink Answers Sent
6. Interpreted Ink Answers Retrieved
7. Summary Data Stored
8. Summary Data Retrieved

Instructor Tablet

Instructor Slides
Instructor Authoring Tool
Summary Data

Student Tablet

Student Slides
Ink Interpretation
Aggregation
Repository
System architecture

1. Slides Saved
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Status

• Eight months into two year project
  – Pilot study Fall '05 term
  – Recitation for MIT introductory CS class (6.001)
  – Design, implementation of system to be deployed Spring '06 term

• Planned Evaluation
  – 3 terms in 6.001 recitations (~20 fall, 35 spring)
    * How to test in much smaller class than target?
  – 1 term in lecture (~150 fall, 300 spring)
    * How to test without Tablets for all students?
Pilot study (CP only) Fall '05

- **MIT introductory CS class (6.001)**
  - 98 students; lecture 2 per week, recitation 2 per week
  - 1 lecturer, 3 recitation instructors; all exams, projects, problem sets, final same

- **Students assigned randomly to 5 recitation sections**

- **My recitation had 17 students**
  - given chance to change recitations; 0 changed, 1 didn't participate
  - study run with 15 of 98 students = 15.3%

- **Tablets associated with class**

- **Used Classroom Presenter (no CLP aggregator)**

- **Classroom observation, surveys, interviews**
Preliminary results (CP only) Fall '05*

• **Teaching style**
  – "encouraged, enticed" students to answer questions and solve problems; emphasis on engagement and processing
  – 75% or more of class time spent with questions or problems
  – 35% of top 10% in this recitation on exam 1 (pre-Tablet)

• **Tablets introduced 5th week (of 15 weeks):**
  – 40% of top 10% in this recitation, expected 15.3%
  – ~3 times more students in this recitation were in top 10%
  – 0% of bottom 10%, 8% of bottom 25% were in this recitation, expected 15.3%; no D or F
  – ~ half expected number in bottom 25%
  – middle performed as expected

* In collaboration with David Singer (Brain and Cognitive Science, MIT)
Grades of Students With Tablet PCs and Those Without

![Bar graph showing the deviation of percentage of student grades from expected outcomes for Tablet Users and Non-Tablet Users. The graph compares the performance of students in the Top 10%, Middle 11% - 89%, and Bottom 10% grades.](image-url)
Students who performed in the top third:
- identified Tablet + CP as beneficial only occasionally
- showed increased feelings that 6.001 was easy

Students in bottom third:
- identified Tablet + CP as benefiting them, though not making it easier
- made more use of color, audio recordings
- drew more graphs or drawings related to their work

Did students in the top third learn more easily?
Did students in the bottom third benefit from the ability to learn using different methods?
More questions

- Did Tablet + Classroom Presenter + teaching style help all students?
- Did the average student do better than expected?
- Did students who would have struggled or failed perform better?
More results (2)

- **Students in bottom third also:**
  - were more concerned with anonymity
  - felt uncomfortable seeing their wrong answers displayed
  - wanted more time spent on students' right answers; thought discussion often rushed
  - used Tablet for personal purposes more than top third, but only when felt left behind

- **Students in top third:**
  - enjoyed additional challenging problems, saw Tablet + CP as enabling
  - paid attention
  - if problem was interesting, enjoyed seeing other students' solutions

➢ Can the Tablet + Classroom Learning Partner (CP+aggregation) meet learning needs of both groups?
Spring '05 plans

- Two recitations: one with tablets, one without
- More students: class size of 35 rather than 15
- Repeat classroom observation, surveys, interviews
- Look at:
  - Interaction: e.g. # of responses submitted
  - Learning: exams, projects, problem sets, final exam
- Introduce aggregator mid-term, and repeat above
End with a question

Send me a question or comment about what you saw and heard today about Tablet PCs, or CP, or CLP.

... then let's talk about it (orally!)