Challenging the Advanced First-Year Student’s Learning Process through Student Presentations

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We LIKE the Well-Prepared 1\textsuperscript{st} Year Computing Students …

They:
• Have completed lots of mathematics
• Have taken some data structures
• Can code circles around us
• Aced the AP exam (USA only)
• Like computing
• Are smart!
• Sign up for computing in their first year
...But the Well-Prepared 1st Year Computing Students Don’t Like US

They:

- Study science, engineering, math, business, English, economics, history, etc.
- Lose interest quickly

The phenomenon is global

We may only have one term to retain them
Outline

The promise of learning through teaching

The “capsules” experiment

Reactions, including pedagogical goals met and unmet

Implications for computing education
Learning Through Teaching

(Dankel & Ohlich, 2007; Plimner & Amor, 2006; Ching et al., 2005)

Approaches
1. Peer teaching using graduate tutors
2. Research followed by peer teaching
3. Research, presentation & communication skills

Benefits
1. Social bonding
2. Improved intrinsic motivation
3. Increased learning

Caveats & Cautions
1. Upper division undergrads
2. Elective classes
3. “Soft” material seen as pointless
4. Significant structure is critical for success
Advanced 1st-Year Students
(Roberts, 2000; Carbone, 1997; Bruce, 1994)

• Often like self-directed activities
• May prefer large, complex projects
• Enjoy and absorb highly advanced material

• Sometimes are left out of pedagogical reform
Our Computing Honor Students

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Male</td>
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<tr>
<td>Female</td>
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<tr>
<td>Freshman</td>
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</tr>
<tr>
<td>Sophomore (by standing)</td>
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<tr>
<td>Junior (by standing)</td>
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<tr>
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<td>Software Engineering</td>
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<td>Computer Engineering</td>
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<tr>
<td>Mechanical Engineering</td>
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<td>Electrical Engineering</td>
<td>3</td>
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<tr>
<td>Physics</td>
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</table>
# Ambitious Weekly Topic Coverage

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Environment – IDE, version control, unit testing, API, big-Oh, exceptions</td>
</tr>
<tr>
<td>2</td>
<td>UML, pair programming, inheritance, polymorphism, abstract classes, interfaces, debugging</td>
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<tr>
<td>3</td>
<td>Arrays and array lists, GUI design w/Swing, event-driven programming, applets</td>
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<tr>
<td>4</td>
<td>Introduce first large project: databases; exam 1; queries &amp; SQL, searching algorithms, simple sorting algorithms, efficiency</td>
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<tr>
<td>5</td>
<td>Project work time; presentations of project screen layouts</td>
</tr>
<tr>
<td>6</td>
<td>Project work time; file I/O, advanced GUI topics</td>
</tr>
<tr>
<td>7</td>
<td>Introduce second large project: networks; threads, linked lists, project work</td>
</tr>
<tr>
<td>8</td>
<td>Project work time; generics, stacks and queues, advanced linked lists</td>
</tr>
<tr>
<td>9</td>
<td>Student-selected topics (Graphics2D; animation; inner classes), exam 2</td>
</tr>
<tr>
<td>10</td>
<td>Status report presentations; project work time</td>
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</tbody>
</table>
Our Pedagogical Goals

1. Improve skills
   – research
   – oral communication
   – teaming
2. Create self-directed learners
3. Deepen understanding of course material
4. Increase intrinsic motivation for computing

9/15/2007
The Capsule Experiment

The students...

- Research content in advance
- Engage class in relevant activity
- Prepare formal presentation
- Receive evaluation
- Demonstrate topic
- Assess peer learning
Instructor Modeling and Guidance

**The instructor...**

- Leads discussion of capsule development
- Models several capsules
- Distributes a detailed grading rubric
- Debriefs on class progress weekly
- Provides detailed feedback to each team
Data Collection

• Surveys to evaluate experience & perceptions
  – Pre-course demographics, expectations
  – Post-course impressions & perceptions of change
  – Focus on experience & comfort levels
• Peer evaluations for each capsule
• Instructor journals
  – Daily record of events, observations
## Results – Good News

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<th>Post-course Survey</th>
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*Statistically significant, p< .05
## Results – Not So Good News

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<tr>
<td>Capsule enjoyment*</td>
<td>2.74</td>
<td>2.22</td>
</tr>
<tr>
<td>Computer Science enthusiasm*</td>
<td>3.41</td>
<td>2.94</td>
</tr>
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Increased Learning but Resistance to Paradigm Change

“I learned even more than I would have just on the student side”

“I would much rather have a professor teach…That is what I am paying … for”
Lack of Trust in the Process

“Really let us know what needs to be taught and that its [sic] correct”

“No one gets a perfect grade, meaning that some part of the teaching is not satisfactory without a professor teaching”
Increased Ownership as Learners

“[A benefit of the capsule experience was] self-teaching ability”

“…by the end I was trying to find interesting ways to do things”
Instructor Journal Evaluations

- Sometimes we picked up on student perceptions
  - Workload worries
  - Improving content understanding
  - Improved presentation skills
  - Struggling students were quickly identified

- Sometimes we missed the boat
  - Instructors more optimistic, seeing improvements
  - Unaware of diminishing confidence, anxiety
In Spite of Incredible Learning

• Why was there such intense resistance to change?

• Why didn’t we fully recognize what was happening?

• What can we do better next time?
Understanding Resistance to Change
(Howles, 2007; Loui, 2005; Allert, 2004; King & Kitchener, 1994)

• First year of college is a culture shock
• Academic maturity may exceed social maturity
• Traditional instruction has been good to these students
• (Perceived) lack of structure => anxiety
• Authority relationships inhibit full honesty

It is easy to forget these issues when exciting work is happening in the classroom!
Leverage the Strengths, Address the Weaknesses and Move On!

- Increase the visibility of the instructor
  - Introduce, setup every class, all term
  - Model capsule development more explicitly
  - Periodically deliver “tricky” capsules
- Provide additional cognitive structure
  - 3 phase incremental capsule development
- Reduce the overall perceived risk
  - Fewer capsules, more time for each one
Additional Strategies for Reducing Anxiety and Building Trust

• Increase perceptions of student control:
  – Phase 1: Choose topics based on interest
  – Phases 2 & 3: Choose teammates & topics

• Provide a break from social demands
  – Make some non-capsule projects individual
  – Allow them to choose team members & build supportive relationships
Advanced 1st Year Students can learn by teaching

- Improved at research and communication
- Became self-directed learners
- Learned lots of material when they taught
- Decreased motivation for computing

How to increase success and motivation?

- Provide lots of structure
- Ease them into it
- Design innovative pedagogy with affect in mind

We too can learn a lot from so-called “failure”

Questions?