Find a Topological Sort for the following graph:

A → C → D → E → H → G → F → B → I

Supporting Active Learning and Example Based Instruction with Classroom Technology

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Joint work with Richard Anderson, K.M. Davis, Natalie Linnell, Craig Prince, Valentin Razmov

Classroom Technology
- Rich Interaction Systems
  - Classroom Presenter
  - Ubiquitous Presenter (UP)
  - DyKnow
- Other Technologies
  - Classroom Response Systems (clickers)

Example Based Pedagogy in Algorithms & Data Structures
Use of concrete problems is critical:
- Focus for students
- Assess understanding
- Discuss specific instances

Technology Supports Pedagogy
- Distribution of rich examples
- Collection of feedback from students
- Display of student artifacts for discussion

Outline
- Example Based Pedagogy & Technology
- Algorithms & Data Structures Courses
- Instructor Goals
- Example Activities
- Conclusions
Courses (Summer 2005 - Winter 2007)

- Algorithms
  - 3 courses
  - 25-36 students
- Data Structures
  - 5 courses
  - 15-51 students (avg. 37)

Pedagogical Goals

- Problem Exploration
- Individual Discovery
- Reinforcement
- Classroom Assessment

Problem Exploration

- Ensures understanding of the problem
- Promotes discovery of properties & limitations
- Motivates interest in algorithmic solutions

Individual Discovery

- Working on a concrete example leads students to discover a specific result
- "A-ha!" moments

Find the Minimum Spanning Tree

Reinforcement & Assessment

- **Reinforcement** of a concept by working concrete example
- **Assessment** of student understanding by viewing student responses
- Provide **Feedback** to students by discussing submitted responses
Create the Huffman tree for:
f:5, e:9, c:12, b:13, a:16

Encode “cab”

Example Activities

Problem Exploration
Determine the LCS of the following strings
BARTHOLOMEWSIMPSON
KRUSTYTHECLOWN

Find a minimum value cut

Individual Discovery
Decode the following

Reinforcement

Classroom Assessment
Identify the Strongly Connected Components
Determining M and L for a B-Tree
1 Page on disk = 1 Kbyte
Key = 8 bytes, Pointer = 4 bytes
Data = 256 bytes per record (includes key)

Splay D
Wide Range of Use

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.

Designing Activities

Find a satisfying truth assignment

Find a maximum flow

A DFS from vertex v gives a simple algorithm for finding a cycle containing v.

How does this algorithm work and why?

Use of Class Time

- One tablet based lecture per week
- 3-5 activities per 50-minute lecture
- 50% of class time dedicated to activities
- 7:17 minutes per activity
- Work time was 65% of activity time

Use of Class Time

Lectures where the system was used were:

- 30% More engaging
- 24% More active learning
- 24% Preferable to days without
- 17% More fun
- 16% Understood better
- 10% Slower Pace
- 2% More Distracting

Student Evaluation

- 94% claimed positive effect on learning experience
- 85% claimed they were more engaged in lectures where system was used

Evaluation

94% claimed positive effect on learning experience
85% claimed they were more engaged in lectures where system was used

March 8, 2007  SIGCSE 2007  19

March 8, 2007  SIGCSE 2007  20

March 8, 2007  SIGCSE 2007  21

March 8, 2007  SIGCSE 2007  22

March 8, 2007  SIGCSE 2007  23

March 8, 2007  SIGCSE 2007  24
Conclusions

Existing technology can:
- Support instructor’s pedagogical goals in teaching of Algorithms and Data Structures
- Encourages instructors to clarify pedagogical goals

Announcement:
Release of Classroom Presenter 3

- Beta Release – April 1
- Current builds available from
- Most significant changes from CP2
  - Support for TCP/IP networking
  - Improved ink support
  - Direct import of PPT (no need for deckbuilder)
- For more information contact
  - Richard Anderson, anderson@cs.washington.edu

Questions?

Email: Ruth Anderson (rea@cs.washington.edu)
Downloads:
Acknowledgements:
- Microsoft Research, External Research and Programs
- HP

BOF Tonight:
Pedagogy for Electronically Supported Classroom Interaction
Thursday, March 8, 6:45 PM - 7:30 PM
Marriott - Salon I

Sample Student Responses

Find a topological order for the following graph

Find a topological order for the following graph

impossible because of this cycle
Find a topological order for the following graph

Classroom Presenter
- Classroom interaction system
- Built for use with Tablet PCs
- Two main classroom usage scenarios:
  - Instructors can annotate (and later save) slides in ink
  - Instructors can pose problems (on slides) that students respond to by writing on slides and submitting their work anonymously
- Classroom Presenter is freely available for educational purposes

Overall System Goals
1. Increase student engagement
2. Improve feedback to the instructor
3. Promote the participation of all students
4. Facilitate the integration of student work into discussion

General Benefits
- Digital domain
  - Support for archiving, distribution, and analysis
- Integration with lecture
  - Allows display with data projector
- Efficiency
  - Reducing overhead of distribution and collection
- Simultaneity
  - All students work at once to increase contribution rates
- Additional communication channels
  - Easier to express certain ideas
  - Overcomes communication barriers

Ink Use in Student Artifacts
- Expressing Answers
  - Path taken
  - Elaboration
  - Unexpected response types
- Personalization
  - Expressing emotions
  - Doodling
  - Tagging
Survey Results

<table>
<thead>
<tr>
<th>Course</th>
<th># Students</th>
<th>Total # Classes Used</th>
<th>Total # Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Structures</td>
<td>15</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>Algorithms</td>
<td>20</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>Data Structures</td>
<td>51</td>
<td>7</td>
<td>24</td>
</tr>
<tr>
<td>Section A</td>
<td>47</td>
<td>7</td>
<td>23</td>
</tr>
</tbody>
</table>

High Participation Rates

<table>
<thead>
<tr>
<th>Course</th>
<th>Average Participation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algorithms</td>
<td>69%</td>
</tr>
<tr>
<td>Data Structures-a</td>
<td>88%</td>
</tr>
<tr>
<td>Data Structures-b</td>
<td>81%</td>
</tr>
</tbody>
</table>

Consistent Participation: Over the Quarter

Consistent Participation: Over 50 minutes
“Silent” Participation Existed

Observation:
Some students worked on an activity but did not submit a response.

In Algorithms:
- 69% submitted a response
- 86% submitted a response + worked but did not submit

“Did the system make you more likely to do the activity?”

- 73% more likely to do the activity
- 16% same
- 11% less likely

“How important that your response be displayed?”

- 54% prefer their response be shown
- 42% don’t care
- 4% prefer their response NOT be shown

“How did you feel when your response ...”

**was displayed:**
- 52% good, proud, excited, happy
- 29% fine, o.k., indifferent

**was not displayed:**
- 28% disappointment
- 53% fine, o.k., indifferent

Other:
- 7% stress
- 4% getting feedback

Other:
- 5% not time to show all
- 6% might be wrong

END