Goal

- Create **new pathways** for undergraduate **education majors** to become **computationally educated** secondary teachers

Highlights

- **CS teaching endorsement** (supplemental licensure)
- **Computational thinking module** (and WebQuest)

New Courses

- **Contemporary Issues in Computing**
- **Methods of Teaching Computer Science**
Overview

Short Term Goal
• Prepare future educators to present their subject areas using ideas from computational thinking

Long Term Goal
• K-12 students will have greater exposure to computing in general

Our Approach
• Develop a one-week module on CT (what & how)
• Embed CT in required courses for education majors
• Survey the students before/after taking the module
CT Pop Quiz

Which of the following is NOT like the others?

[A] People standing in line at the store

[B] List of print jobs waiting to be printed

[C] Set of tennis balls in their container

[D] Vehicles lined up behind a toll booth

[E] Patients waiting to see the doctor
CT Pop Quiz - Answers

Which of the following is NOT like the others?

[A] People standing in line at the store (queue)

[B] List of print jobs waiting to be printed (queue)

[C] Set of tennis balls in their container (stack)

[D] Vehicles lined up behind a toll booth (queue)

[E] Patients waiting to see the doctor (queue)
Why students picked the tennis balls:
- "...were not waiting to go anywhere."
- "...had nothing to do with people."
- "...were not moving towards a goal."
CT Module Overview

Concepts from CT that we presented to the students
What is Computational Thinking?

Definition

- “CT involves solving problems, designing systems, and understanding human behavior, by drawing on the concepts fundamental to computer science.”

Vision

- A fundamental skill used by everyone by the middle of the 21st century (i.e., like reading, writing, and arithmetic).

Overview of Lecture 1

Focus: What is CT?

- CT in daily life
  - Driving directions
  - Buying movie tickets

- Abstraction & logical thinking
  - Recall "queues vs stack"
  - Inductive/Deductive reasoning

- Algorithms and debugging
  - PB&J sandwich activity
Another Example

Which of the following is NOT like the others?

[A] Files and directories on a hard disk
[B] Parents and children in a pedigree chart
[C] Brackets in the NCAA basketball tournament
[D] My closest friends on Facebook / Twitter
[E] The format of XML or PDF documents
Which of the following is NOT like the others?

[A] Files and directories on a hard disk (tree)

[B] Parents and children in a pedigree chart (tree)

[C] Brackets in the NCAA basketball tournament (tree)

[D] My closest friends on Facebook / Twitter (graph)

[E] The format of XML or PDF documents (tree)
Student Responses - Trees vs Graph

Some of the confusion:
- [C] "Brackets branching inward instead of outward."
- [E] "All others are linked to you; PDFs are not linked."
- [E] "Everything else branches; PDFs not able to branch."

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Overview of Lecture 2

Focus: Teaching CT in K-12

- Connections to educational theory
  - Algorithms vs heuristics
- Ideas for presenting algorithms
  - Towers of Hanoi role play
- Using technology to motivate CT
  - Facebook constellation
- Online resources (new in 2011)
  - CSTA, ACM, CS Ed Week
  - CS Unplugged, CS4FN
  - Google's CT repository
Attitude Survey Results
Research Study

How does knowledge of CT affect one's attitude toward CS?

Pre-Post Design

- Sent survey to 155 education majors
- 100 responded (64.5% return rate)
  - 78 females; 22 males
  - 55 elementary; 45 secondary

Survey Contents

- 16 Likert-scale (adapted from Hoegh & Moskal, 2009)
- 4 free response (e.g., What is CT? How does it relate?)

See the paper for details!
Participants’ View of CT

Sample Student Responses

A1: Computational thinking involves problem solving with algorithms and logic.

A2: Knowing how to use computers for problem solving.

A3: It is being able to solve problems in a new way, sometimes like a computer.

A4: Thinking above and beyond what normally comes to mind.
Sample Student Responses

A1: Computing is the use of computers or some other form of technology to solve a problem.

A2: Computing is the science of solving a problem using some pre-set method that has been established.

A3: Being able to use and apply computer skills to daily life.
Integrating CT into the Classroom

Sample Student Responses

**A1:** In the linguistic sense, we can teach students how language is inherently computational, especially in regards to syntax and morphology.

**A2:** Using programs that allow students to learn more about computers.

**A3:** Make it standard in every class.
Lessons Learned
CT Module "Version 2.1"

- Module changes
  - Focused more on how CT can be integrated in core content areas
  - Facilitating understanding of CT through additional concrete examples
  - Clicker questions to foster discussion of CT concepts
  - Removed concepts that didn't work
    - e.g. "Towers of Hanoi" demonstration for recursion

- WebQuest - online version of module

- Quasi-experimental study
Future & Ongoing Work

- CS Teaching Endorsement

- CS Teaching Methods Course
  - to provide students with pedagogical and content knowledge and experiences to be effective computer science teachers in high school.

- 2011 workshop about:
  - raising awareness of the CS Principles efforts
  - sharing experiences of challenges and opportunities
  - creating new synergies between computer science faculty, education faculty, and high school teachers
Summary

Approach
- Presenting computational thinking to all education majors

Results
- Attitudes toward computer science become more favorable
- Increased interest in teaching general computing principles

See the paper for:
- Other ideas for module content
- Additional discussion of results
- List of post-survey questions

CT lecture slides: http://cs4edu.cs.purdue.edu/comp_think