

Piloting Pathways for Computational Thinking in a General Education Curriculum

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<http://www.towson.edu/cosc/computationalthinking>

Computational Thinking

"Computational thinking is a fundamental skill for everyone, not just for computer scientists. To reading, writing, and arithmetic, we should add computational thinking to every child's analytical ability." Wing, 2006

"Computational thinking is rapidly becoming an essential skill for students in all disciplines" NSF Solicitation CISE Pathways to Revitalized Undergraduate Computing Education

Computational Thinking Manifesto

Wing, 2006

- Computational Thinking is:
 - Conceptualizing, not Programming
 - Fundamental, not rote skill
 - Way that humans, not computers think
 - Combines and complements mathematical and engineering thinking
 - ideas, not artifacts
 - for everyone, everywhere

Computational Thinking is not necessarily Programming!

- Given today's state of the art, not everyone can be or should be a programmer
- Current programming languages and tools don't work for many people
- We don't want to make everyone take a CS programming course!

Computational Thinking Questions

(based on Wing '06)

- How hard is a problem? What's the best solution?
- Can it be solved exactly? If not, how might it be solved approximately?
- How can we reformulate a problem to make it solvable?
- Can we use randomization?
- Can we solve this by using recursion? Thinking in parallel?
- How can we use abstraction and decomposition to understand a large system? Can we change the system without knowing all details?
- How can we handle errors?
- How do we deal with scarce resources?
- What are the tradeoffs involved in different approaches to a problem?

Examples of Computational Thinking

- Grabbing supplies for the day before you leave the house
 - prefetching (Wing 06)
- Searching for lost mittens -backtracking (Wing 06)
- Selling concert tickets from multiple locations (Lewandowski, et al. 07)
- Analyzing social networks
- Simulation/modeling
- Traffic flow/Route planning
- Generative procedures in art & creative applications of computation
 - Jackson Pollock, William Burrough, Steve Reich, etc...

Abstraction - London Underground #2

http://en.wikipedia.org/wiki/Image:Tube_map_thumbnail.png



NSF CISE Pathways to Revitalized Undergraduate Education (CPATH)

- CISE: NSF Computer & Information Sciences and Engineering Directorate
- RFP: <http://www.nsf.gov/pubs/2008/nsf08516/nsf08516.htm>
- “The CPATH program seeks to promote projects that will revitalize undergraduate computing education on a broad scale and develop innovative academic partnerships and pathways that will prepare undergraduates to enter, lead, and thrive in the challenging workplaces and computing environments of the future. ”

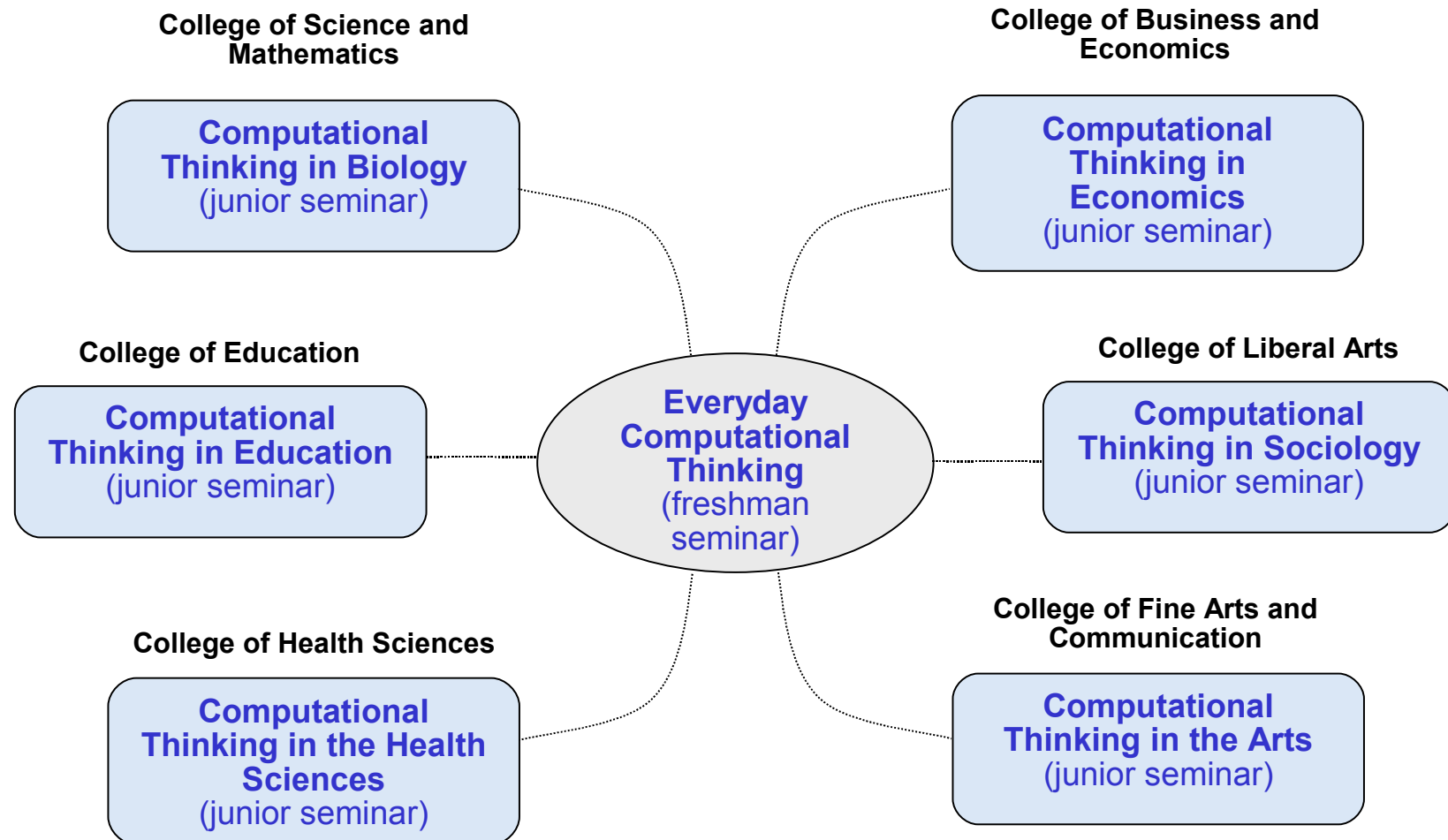
Our project

- "Piloting Pathways for Computational Thinking in a General Education Curriculum"
- Conceptual Development and Planning
 - one of 5-10 awarded
- 2 years - \$140K
- Dierbach and Hochheiser (PIs), Ariza (Faculty Associate), Doherty (Assessment)
- Basic Idea: Include Comp. Think. to Gen. Ed. as a Freshmen seminar option

Plan

- Introduce Computational Thinking via courses in revised General Education scheme under development on campus
 - option for required Freshman seminar
- As proposed
 - “Everyday Computational Thinking” - Freshman Seminar to be developed by Computer Science (C.D. & H.H.)
 - Discipline-specific courses
 - developed by non-CS faculty
 - Funding - \$5K/faculty member - to support proposal development and creation of two courses
- Try to find homes in new Gen. Ed. model
- Honors College as alternative

Pervasiveness of Computational Thinking



Our proposed course: Everyday Computational Thinking

- Use familiar examples/problems from everyday life to motivate computational thinking
- Social Networks "Find friends that you might know" - **graph theory**
- 5 roommates, 1 bathroom - **resource allocation, scheduling, deadlock avoidance**
- concert ticket sales - **concurrency**
- getting to school and running errands - **shortest paths, approximations**
- movie recommendations - **modeling, nearest-neighbors**
- scheduling classes - **constraints, optimizations**
- etc.

Moving beyond Computer Science

- **English** - content analysis (word frequencies), "poetry-writing" software
- **Sociology** : - social network analysis
- **Political Science**: "Intractable Conflict as an Attractor: Presenting a Dynamical Model of Conflict, Escalation, and Intractability"
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=734963
- **Dance**: "Computational Model of Human Creativity in Dance Choreography"
<http://axon.cs.byu.edu/CreativeAI/Accepted/Nahrstedt.pdf>
- **Law**: Stanford Computational Law <http://complaw.stanford.edu>
- **University of Edinburgh**: <http://www.inf.ed.ac.uk/research/programmes/comp-think/>
- **Carnegie-Mellon**: <http://www.cs.cmu.edu/~CompThink>

Procedure/Timeline

- Presentations to each school in fall
- Work with interested faculty to develop proposals
- 2 faculty to get \$5,000 stipends to support development
- Workshop in January to facilitate proposal development
- Spring: Submit proposals for approval
- Teach pilot course in '09-'10
- Assess for success
- Submit proposal for follow-on "Transformative Implementation" grant - \$1,000,000 / 3 years

Next Steps

- More Info:

<http://www.towson.edu/cosc/computationalthinking>

- Contact us if you're

- thinking about developing a class
- looking for more details on what computational thinking is
- in need of any further clarification or guidance

A Final Plug

- Interesting in doing something with these ideas next semester?
 - Gail Kaplan's "Honors Seminar: "Mathematics: Explorations and Connections"
 - Similar ideas - explore math through different topic
 - Faculty from all areas
 - Participate for a few classes
 - Contact Gail for details (gkaplan@towson.edu)