

Enterprise Computing Community - ECC 2010

Computational Thinking in K-12

Chair: Dean Roger L. Norton, Marist College

June 13 - 15, 2010



Enterprise Computing Community - ECC 2010

Incoming Freshman in Computer Science since 2000

- Decreased more than 70%
- Closer to 80% for women

Enterprise Computing Community - ECC 2010

What are K-12 Schools doing to entice these students into CS?

- Keyboarding
- Computer literacy
- AP Computer Science Course

Enterprise Computing Community - ECC 2010

The AP Computer Science Course

- Taught in less than 10% of our high schools
- Taken by only 14,529 students in 2008, with only 18.3% women.
- ✓ 204,564 took the Calculus AB exam
- ✓ 141,321 took the Biology exam
- ✓ 96,282 took the Statistics exam

Enterprise Computing Community - ECC 2010

Computer Science/10,000

To develop an effective new high school curriculum for computing, taught in 10,000 high schools by 10,000 well-qualified teachers by 2015!

Enterprise Computing Community - ECC 2010

Gold Standard CS AP Course

The new AP course will not be programming-centric but will instead focus on the fundamental concepts of computation. It will be engaging, accessible, inspiring, and rigorous. It will be a course that is highly relevant to all students, regardless of their major, but especially crucial for students planning to major in STEM disciplines. We expect that this new course will be a target for K-8 curriculum development, as well as an impetus for college curriculum reform. It is intended that the course carry college credit, if not placement, at many schools.

Jan Cuny
Program Officer for Broadening Participation in Computing
National Science Foundation

June 13 - 15, 2010

Enterprise Computing Community - ECC 2010

Gold Standard CS AP Course

The course is being developed by an AP Commission, headed by Owen Atraschan of Duke University

Advisory Board:

Duane Bailey (Williams College)
Gail Chapman (CSTA)
Mark Guzdial (GA Tech)
Jim Kurose (UMass)
Tom Cortina (CMU)
Susanne Hambrusch (Purdue)
Michelle Hutton (High school, TX)
Rich Kick (High School, CA)
Deepak Kumar (Bryn Mawr)
Richard Pattis (UC Irvine)
Eric Roberts (Stanford)
Wanda Dann (Ithaca)
Stephen Edwards (VA Tech)
Juan Gilbert (Auburn)
Larry Snyder (UW)
Cameron Wilson (ACM)

June 13 - 15, 2010

Enterprise Computing Community - ECC 2010

Big Ideas in Computing

1. Computing is a creative activity that draws on a wide variety of fields, such as the natural sciences, mathematics, engineering, social sciences, business, and the arts.
2. Abstraction is a central problem-solving technique in computer science.
3. Algorithms are the essence of computational problem solving.
4. Writing programs is an integral part of solving computational problems.
5. Theoretical and practical limitations affect what can be solved computationally.
6. Computing enables and empowers innovation, exploration, and the creation of knowledge.
7. Computing drives and is driven by economics, culture, society, and ethics.

Enterprise Computing Community - ECC 2010

Introductory Course (Pre-AP)

- Intended for students who have minimal experience with computing
- Designed for all students, even those who are not planning on STEM careers.
- Goes beyond computer literacy to fluency in the fundamentals of computing and **computational thinking**
- It will use an inquiry-based instructional approach and engage students with exciting, 21st century applications

June 13 - 15, 2010

Enterprise Computing Community - ECC 2010

Existing AP CS A Course

- Will be maintained for those schools who do not to relinquish the existing AP course
- Geared for students who want to go beyond the Gold Standard course
- Mirrors the first course taught in many CS departments
- Potentially becomes a much more interesting, project-based course

Enterprise Computing Community - ECC 2010

My Grand Vision for the Field

- Computational thinking will be a fundamental skill used by everyone in the world by the middle of the 21st Century.
 - Just like reading, writing, and arithmetic.
 - Imagine every child knowing how to think like a computer scientist!
 - Incestuous: Computing and computers will enable the spread of computational thinking.
 - In research: scientists, engineers, ..., historians, artists
 - In education: K-12 students and teachers, undergrads, ...

J.M. Wing, "Computational Thinking," CACM Viewpoint, March 2006, pp. 33-35.
Paper off CISE AC website; paper and talks off <http://www.cs.cmu.edu/~wing/>

June 13 - 15, 2010

Enterprise Computing Community - ECC 2010

Examples of Computational Thinking

- How difficult is this problem and how best can I solve it?
- C.T. is thinking recursively
- C.T. is reformulating a seemingly difficult problem into one which we know how to solve
- C.T. is judging a system's design for its simplicity and elegance
- C.T. is taking an approach to solving problems, designing systems, and understanding human behavior that draws on concepts fundamental to computer science

June 13 - 15, 2010

Enterprise Computing Community - ECC 2010

Simple Daily Examples

- Looking up a name in an alphabetically sorted list
 - ❖ *Linear: start at the top*
 - ❖ *Binary search: start in the middle*
- Standing in line at a bank, supermarket, customs & immigration
 - ❖ *Performance analysis of task scheduling*
- Taking your kids to soccer, gymnastics, and swim practice
 - ❖ *Traveling salesman (with more constraints)*
- Cooking a gourmet meal
 - ❖ *Parallel processing: You don't want the meat to get cold while you're cooking the vegetables.*
- Storing away your child's Lego pieces scattered on the LR floor
 - Using hashing (e.g., by shape, by color)
- Doing laundry, getting food at a buffet
 - ❖ *Pipelining the wash, dry, and iron stages; plates, salad, entrée, dessert stations*
- Even in grade school, we learn algorithms (long division, factoring, GCD, ...) and abstract data types (sets, tables, ...).

June 13 - 15, 2010



National Science Foundation
WHERE DISCOVERIES BEGIN

Enterprise Computing Community - ECC 2010

Computer Science/10,000

Introductory Course (Pre-AP)

Gold Standard CS AP Course

Existing AP CS A Course