CyberCivics: A Novel Approach to Reaching K-12 Students with the Social Relevance of Computing

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Overview

- Definition of CyberCivics
- Motivation and introduction
- eVoting Curriculum
- Digital Privacy Curriculum
- Future work
- Summary
Definition of CyberCivics

- The study of contemporary social and political issues that grow out of computer-science related technologies

*Examples*: electronic voting, privacy of digital communications, data mining, intellectual property rights, digital rights management, and more
Motivation and Introduction

- Student interest in CS has declined
  - Incoming freshmen declaring CS majors fell 70% between Fall 2000 and 2005
  - Total CS bachelor’s degrees awarded fell 43% between 2003-2004 and 2006-2007
  - Number of new CS majors in Fall 2007 was down 50% from Fall 2000

Motivation and Introduction

- Participation by women is also down
  - CS is the only science in which the number of bachelor’s degrees declined 1983-2004
  - Share of CS bachelor’s degrees awarded to women fell from 36% to 27%, 1983-2002
  - Incoming female freshman reporting interest in CS as a major is at its lowest point since the late-1970s

Motivation and Introduction

- Traditional CS K-12 outreach programs miss many qualified students
  - Class sizes in technical elective courses are often very small
  - Students choosing technical electives are mostly male; many are not college-bound
  - The number of students taking the AP Exam in CS has been flat since 1997 and lags all other STEM disciplines
Motivation and Introduction

- Enter CyberCivics
  - AP Government & Politics
    - Relatively large classes
    - Highly-qualified students
    - Diverse populations
  - Other Social Studies classes
    - Required for all students
    - Large, diverse enrollments
Motivation and Introduction

CyberCivics is relevant:

Veterans Administration Loses Data on 1.8 million
-- Consumer Affairs, 2/13/07

Sony BMG Hacking into CD Buyers’ Computers
-- FOX News, 11/3/05

Audit Finds Many Faults in Cleveland’s ’06 Voting
-- NY Times, 4/20/07

Machines Record Votes Inaccurately in Tests
-- Dayton Daily News, 3/20/07

Experts: Wi-Fi Eavesdropping Persists...
-- Boston Globe, 8/7/07
eVoting Curriculum

- Piloted in AP Government & Politics, Spring 2006
- Enrollment: 18 students
- Approximately 50% female
- Included top four seniors by GPA
- Four-week curriculum (daily), starting after AP Exams in mid-May
eVoting Curriculum

- Curriculum outline
  - Unit 1 (1 week): Overview of CyberCivics
  - Unit 2 (2 weeks): Introduction to Programming with Python
  - Unit 3 (1 week): Simulation of a Direct Recording Electronic Voting System
Unit 1 objectives:

- Define CyberCivics and explain how scientific solutions may be applied to a number of contemporary social/political problems
- Write concrete, step-by-step English instructions to complete simple tasks
- Describe computer programming in general terms and explain how programs are created
- Write basic interactive Python statements in the IDLE environment to complete simple tasks
Unit 2 objectives:

- Describe the steps of the programming process, including analysis, modeling, coding & debugging
- Discuss basic programming structures such as functions, decision statements, and loops, and describe how these are used in Python
- Write short programs in Python to solve a variety of simple problems
- Discuss some basic approaches for testing and debugging Python programs
eVoting Curriculum

Unit 3 objectives:

- Discuss some widely-held concerns with the use of direct-recording electronic (DRE) voting machines in the U.S.
- Describe some basic requirements for secure, reliable DRE voting systems
- Participate in a mock election and apply basic debugging techniques to help uncover errors in electronic voting program source code
- List some computer science career fields and discuss the outlook and median salaries for each
eVoting Curriculum

- **Equipment and materials**
  - TV, DVD player (School)
  - *Hacking Democracy* (Instructor, $22 for DVD)
  - Computers for student programming activities (School)
  - GUI-based Python interpreter (Open Source)
  - *Start Programming with Python* tutorial (GNU Free Documentation License)
  - AccuVote-TSX simulation (Premier Election Solutions; available online)
  - DRE simulation (Freely available from us)
eVoting Curriculum

- Outcomes & Lessons Learned
  - eVoting objectives are challenging, but achievable
  - End-of-year scheduling not ideal, particularly for graduating seniors
  - Frequent reminders of relevance are important during Unit 2 programming activities. News headlines work well for this.
  - Ongoing support from the classroom teacher is critical
  - Success indicators are mostly anecdotal
Digital Privacy Curriculum

- Piloted in AP Government & Politics, Fall 2007
- Enrollment: 38 students, in two sections
- Approximately 60% female
- Two-week curriculum (daily), starting in late-September
Digital Privacy Curriculum

- **Curriculum outline**
  - **Unit 1 (3 days): Introduction to CyberCivics**
    - Field trip to Clarkson University Applied CS Labs
    - Definition of CyberCivics & Privacy
  - **Unit 2: (7 days) Digital Privacy Issues & Activities**
    - Key logging: Use & Abuse (2 days)
    - RFID: Use & Abuse (2 days)
    - Databases and Data Mining (2 days)
    - Wireless Networks (1 day)
Digital Privacy Curriculum

- Unit 1 objectives (Field trip):
  - Describe how some routine computing activities can be used to fool innocent parties into divulging personal information
  - Using Wireshark, observe, record, and analyze your own Internet activity
  - Use a Web browser to explore a low-interaction honeypot and describe the type of data captured
  - List some computer science career fields and discuss the outlook and median salaries for each
Digital Privacy Curriculum

- Unit 1 objectives (Introduction):
  - Define CyberCivics
  - Define privacy, and explain why it is an important right in a free society
  - List some digital technologies that may threaten privacy and describe how these technologies can be used to subvert privacy rights
  - Explain why “I’ve got nothing to hide” may represent a false dichotomy between security and privacy in modern society
Digital Privacy Curriculum

- Unit 2 objectives (Keylogging):
  - Describe what keyloggers are and briefly explain how they work
  - Explain how hardware and software keyloggers are typically installed on both public and private computer systems
  - Describe how keyloggers are used to violate the privacy of computer users
  - Demonstrate some ways in which computer users can guard against privacy threats from keylogging
Unit 2 objectives (RFID):

- Briefly describe what RFID is and how it works
- List some common applications for RFID technology and describe its advantages
- Discuss some privacy concerns associated with RFID in consumer products, access control, etc.
- Given an **RFID reader** and several tags, describe how factors such as antenna size, orientation, and power levels affect the range of readers
Unit 2 objectives (Databases):

- Define database and give some examples of database use in everyday life
- Define the terms table, row, column, record, field, and primary key
- Define SQL and describe the clauses used in simple SELECT queries
- Define relational database and describe how tables can be joined in simple queries
- Given several examples as reference, write some simple SQL queries
Digital Privacy Curriculum

- Unit 2 objectives (Wireless networks):
  - Describe what WiFi networks are and list the major types currently in use
  - Discuss some privacy concerns associated with use of unsecured WiFi networks
  - Given a choice between WEP or WPA encryption, explain why WPA is the better choice
  - List and describe some other ways users can mitigate privacy risks on home networks
  - Discuss some of the legal issues involved with unauthorized use of WiFi networks
Digital Privacy Curriculum

- Equipment and materials
  - Clarkson Applied Computing Labs
  - Tutorials and topical readings (Instructor)
  - Laptops & WiFi router (Instructor)
  - VMware player and Linux (Free and Open Source)
  - Commercial keylogger (Temporary license)
  - RFID exploration kits (ThinkGeek, $100)
  - Online SQL tutorial (http://sqlzoo.net)
  - Kismet and Aircrack-ng (Open Source)
Outcomes & Lessons Learned

- Shorter, less technical activities work well
- Tighter integration with regular curriculum increases student acceptance and interest
- Female students appear less likely to report understanding than their male students
- CyberCivics must “earn its keep” by adding value to testing outcomes: AP, Regents, etc.
Future Work

- St. Lawrence County STEM Partnership
  - Three-year program
  - Focus is teacher professional development in STEM disciplines
  - Five-day institutes, followed by workshops and curriculum development
  - CyberCivics planned for years 1 and 3
Future Work

- Expand approach to include general Social Studies classes
- Develop activities to suit middle school curriculum
- Recruit teams of Technology and Social Studies teachers within schools and/or districts
Summary

CyberCivics:
- Offers a different approach to CS outreach
- Reaches diverse student populations
- Involves talented students who regularly opt out of technical elective classes
- Provides quality hands-on experiences
- Helps to dispel some negative myths about computing careers