The RPRCC Initiative: Attracting Young Women to Computing Majors (and Retaining Them)

David Klappholz: Stevens Institute of Technology (CS) and member ACM-W Working Group
david@cs.stevens.edu

Martine Ceberio: University of Texas El Paso (CS)

Osama Eljabiri: New Jersey Institute of Technology (CS, IT, IS)

Steven J. Condly: USMA (Ed Psych)
Our Agenda

• Recruiting more young women into software development (SD)-related undergraduate majors...and then retaining them in those majors:
  – female point of view is necessary in the design and development of everything from consumer products to defense-related systems
  – It is feared that the rate of production of software developers is far lower than necessary to fill job openings over the next 5-15 years, especially given baby boomer generation retirements
  – We may be close to tapping the available pool of young men, but the population of potential female software developers is extremely large.
  – A world/classroom with only male faces feels very unnatural
The Situation in Undergraduate SD-related Majors: CS/SwE/IT/IS

• Recruitment
  – Ca. 1960 – ca. 1975/1980: percentage of CS majors who were female was approximately 35%
  – Currently: percentage of entering female CS majors is about 10%-11%

• Retention
  – overall 4-year dropout rate as high as 40%-60%
  – female dropout rate higher than male dropout rate
Enlightened SD Educators’ Feelings

• The early emphasis on programming turns off young women because:
  – they perceive software developers to be solo workers who stay up late at night staring at their computers, hacking code and eating pizza
  – young women are far more socially oriented; prefer team work; prefer work having social relevance...as do not a few young men

• We must convince youngsters that CS/SwE/IT aren’t just programming

• So what else are they?
Retention Problems Among the Few Young Women Who Choose SD-related Majors – or even to take CS1

• Boys ridicule them for being out of their scope / element: Used to be the case; still the case?
• Many boys start programming in middle school or HS, and discovering this causes young women to lose their self efficacy.
  – We’re 5-10 years behind; how can we possibly catch up?
• Margolis & Fisher CMU study
Results of Recruitment Interventions
Results of Retention Interventions
Reasons?

• (Virtually) none of the interventions are based upon what developmental psychologists know about young women’s career interests and how/when they develop

• So, we’re computer scientists in our technical work, but we ignore what (social) science can tell us when it comes to pedagogy / recruitment / retention
Enter SMPY:
30+ Year, 3,000+ Subject Developmental Psychology Research Project

- **MPY** = Mathematically Precocious Youth
- **SMPY** = Study of MPYs
- Begun, at John Hopkins, in 1971, by Julian Stanley, who started an early magnet HS for MPYs
- Moved to Iowa State in 1986, under the direction of Camilla Benbow
- Directed by Camilla Benbow and David Lubinski, at Iowa State, 1991-1998
- Moved to Vanderbilt in 1998, still under the direction of Benbow and Lubinski

- **SMPY** focus is on understanding career/life paths of MPYs – potentially some of the most significant contributors to society – in order to better prepare them, in K-12, for the future
Choice of MPYs for SMPY

• MPYs entered SMPY at age 12-13

• MPYs have been followed, thus far, well into adulthood
Main Results of SMPY

- Adult MPYs aren’t “geeks”:
  - At age 35 most MPYs are happy with their career choices
  - MPYs live well-balanced lives
  - MPYs’ marriages last longer than average marriages
  - Etc.
Incidental Findings of SMPY (Females): I

• Absent mitigating political/financial/social constraints, MPY females go into Science, Technology, Engineering, and Math (STEM) fields involving organic things, i.e., fields involving people, helping people, etc.:
  • Gender balance in biology and near gender balance in many of its variants
  • Gender balance in medicine
  • Considerably larger numbers of women than men in psychology, sociology, etc.
Incidental Findings of SMPY (Females): II

• Female MPYs are better at communication and other inter-personal skills than are young men, so they also go into non-STEM fields like law, advertising, etc.
Incidental Findings of SMPY (Males):

• Absent mitigating political/financial/social constraints, MPY males go into STEM fields involving inorganic things, i.e., fields involving machines, abstractions etc.:
  • Software development
  • Computer hardware
  • Various other branches of engineering
  • Physics
  • Chemistry, but women are getting close in biochemistry
So?

• Many of us have suspected this for years
• Developmental psychology studies that suggest this go back to 1911
• SMPY is the first large-scale, long-term longitudinal study
Further Enlightenment

• SMPY explains why there were far more young women in SD-related majors, and far more female programmers until 1975 or 1980:
  – Until early 1970’s there was an incredibly low quota on admission of young women into medicine and law
  – The quotas were lifted in the early to mid 1970’s
  – 50% of doctors and 50% of lawyers are now women
So...?

- When I told a USC CS professor who has 30+ years SD industry experience, about SMPY’s results, his response was: So, why try to recruit more young women?
- My response: What percentage of SD is programming (inorganic)...and what else is there to SD other than programming (organic)?
What Else is Software Development I

• A. 20%-30% of SD involves programming
• Q. So, what else does the **pre-programming phase** of SD involve?
• A.
  – Requirements engineering – interpersonal interaction
    • Young women are far better at this than young men. (Among other things, they listen to what the client is saying s/he wants.)
  – GUI design – HCI-related
  – Construction of users’ manual – written communication
  – Teamwork
• Q. ...and members of which gender are more interested in and better at all the above?
What Else is Software Development II

• During the rest of the software development life cycle there is V&V (Verification & Validation), risk management, cost and schedule estimation, overall project management, etc.

• there is much more that young women are better at – more interested in – than young men

• NB: We are not suggesting that young women be attracted to do just the non-programming aspects of software development

• But: Starting them/everyone on the “other 70%” raises their self efficacy, and, therefore, retention.
Our Initiative: Real Projects for Real Clients Courses (RPRCCs)

- A real client is a person (organization) who wants software to solve a problem or provide a service.
- A real project is one in which a team of students develops such software, working as a team (problem-based learning, just like learning programming).
- An RPRCC is a course in which students work in teams on real projects for real clients.
Our Initiative: Real Projects for Real Clients Courses (RPRCCs) II

• HS recruitment: pre-implementation RPRCCs with socially relevant agencies as clients, e.g., adoption agencies, child care agencies, poverty agencies, etc.

• Freshman undergrad recruitment: pre-implementation RPRCCs with socially relevant agencies as clients, e.g., adoption agencies, child care agencies, poverty agencies, etc.

• Retention: RPRCCs throughout the curriculum with the following types of clients:
  • Socially relevant agencies
  • College/University faculty and staff
  • Industry and government
HS Recruitment Initiative I

• Four NYC and NJ high schools
  • All-girls NYC public HS
    • High performing: 90+ % go to college
    • Admission based on student’s and parents’ motivation toward higher education
    • 75% Hispanic; 25% African American
  • Harlem Science Magnet
    • High performing
    • Admission based on academic achievement
    • Largely African American
HS Recruitment Initiative II

• Catholic Parochial School in lower middle class NW NJ town
  • High performing: almost 100% go to college
  • Largely Caucasian

• Public HS on NJ shore
  • High performance
  • 25% + Hispanic
  • Significant African American population
  • Majority Caucasian
Undergrad/Freshman Recruiting Activities

• Same type of pre-programming RPRCCs
• Engineering schools, e.g., Stevens and USC Viterbi aren’t good venues as students decide on majors upon entry
Retention Activities

- RPRCCs for SD majors at all undergrad levels
  - Pre-programming RPRCCs concurrent with Intro Programming
  - Intro SwE RPRCCs
  - DBMS RPRCCs
  - Web Programming RPRCCs
  - Computer Graphics RPRCCs
  - Game Programming (training games) RPRCCs
  - Capstone RPRCCs – currently about 15% of SD undergrad programs

- RPRCC-centric Curricula: Stevens
Effects on Existing Courses

• RPRCC-ifying any of the following courses does not result in losing anything that was in the course pre-RPRCC; rather, doing so adds richness to the course:
  • SwE RPRCC
  • DBMS RPRCCs
  • Web Programming RPRCCs
  • Computer Graphics RPRCCs
  • Game Programming (training games) RPRCCs
  • Capstone RPRCCs – currently about 15% of SD undergrad programs
Activities

• Summer workshops for teachers (HS and college)
• Help in recruitment & vetting of clients/projects
• Help in recruiting cool young team mentors
• Sessions with HS parents
• Weekly web sessions to help resolve issues as they arise
Added Benefits

• Better educated software development workforce – both female and male
  – Standish Chaos Reports suggest that high failure rate of SD projects in IT is caused, in considerable measure, because of lack of RPRCC skills.

• Will likely attract more members of minorities as well – because there is evidence that members of minorities are attracted to careers that involve helping members of their communities
Types of Clients

• member of the university’s faculty or staff,
• not-for-profit organization
• local government agency
• local business.
Examples of Projects

• Desktop search application for the corpus of work of a 13C French poet
• Web site for Chinese Children’s Charity
• Web site for Day Care Center
• Portable Personal Medical Information Device
• Proof of Concept of Novel Communication Protocol
• Handheld Device for Local Fire Department
RPRCC Skills

- Identifying stakeholders
- Performing requirements acquisition
- Designing GUI
- Writing preliminary users’ manual
- Project management
- Risk Management
- Cost, Effort, and Schedule Estimation
- Validation and Verification
- ...

= All those skills that cannot be offshored
All RPRCCs

• = everything that software development is other than programming!!!

• Where have I heard people say “we have to let students know that CS isn’t just programming."

• What percentage of our students, male or female go on to be
  – Computer Scientists?
  – Software Developers?
RPRCC-Centric Curriculum

• Curriculum in which there are RPRCCs at all/most levels of the curriculum
• No programming/theory courses need be removed from the curriculum
• ABET accreditable, in fact more easily accredited
RPRCC-Centric Curriculum (cont.)

• Isn’t this just a SWE undergrad program in disguise?
  – No program that calls itself “Software Engineering” has much more in the way of RPRCCs than a capstone...so SWE programs can benefit too.

• Isn’t this the same as a Service-Oriented curriculum?
  – There’s only one (Butler), and we believe it would be better with projects run thru courses

• Aren’t coops and industry internships better?
  – Quite the contrary, coops and industry assignments are improved by RPRCCs for students lucky enough to have them
  – Industry internships are often of the make-work variety
Book Chapter