

Debunking the Geek Stereotype with Software Engineering Education



The Mountain Dew bicep curl is one of many helpful geek exercises.

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Agenda

- **The Geek Stereotype**
- **Educational Debunk-ments**
- **Summary**

- **Acknowledgement: This material is based upon work supported by the National Science Foundation under Grant No. 00305917.**



Agenda



- **The Geek Stereotype**

- Insularity
- Long hours
- Women and others: Lack of relevance of field to society

- **Educational Debunk-ments**

- **Summary**

I want to be a doctor some day



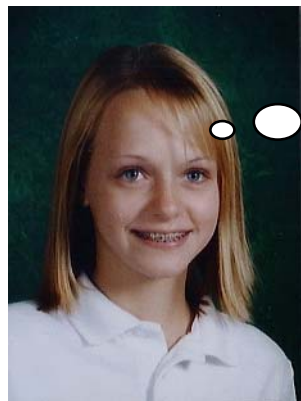
I want to help people



Maybe I have to work hard by myself now, but someday I will help people



I want to be a software engineer some day



Maybe I won't really have to work long hours all alone



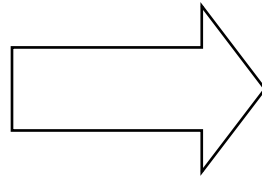
I guess it really is as lonely and hard as they say

Email Survey of Professional Software Engineering

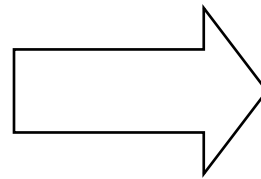
- **359 responses**
- **94 companies**
- **21 countries**
 - **270 responses from US**
- **63% working alone**
- **24% working with one other person**
- **13% working with more than one other person**



Perception



Reality



Myers-Briggs Personality Type

- **153 junior/senior computer science students**
 - NCSU, NC A&T, Meredith College
 - Fall 2004 & Spring 2005

➤ **Introverts: 84 (55%)**

➤ **Extraverts: 69 (45%)**



Stereotype: Long hours

➤ **In education . . .**

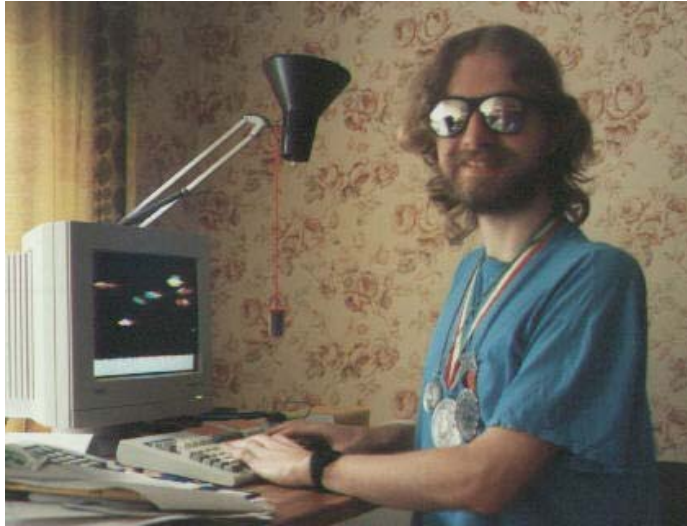
➤ **Teacher survey**

➤ **38 responses**

- 31 said their class was “more” or “much more” work than other classes
- 5 said about the same as other classes
- 2 said less work than other classes

The Stereotype

- Does the stereotype fit some?

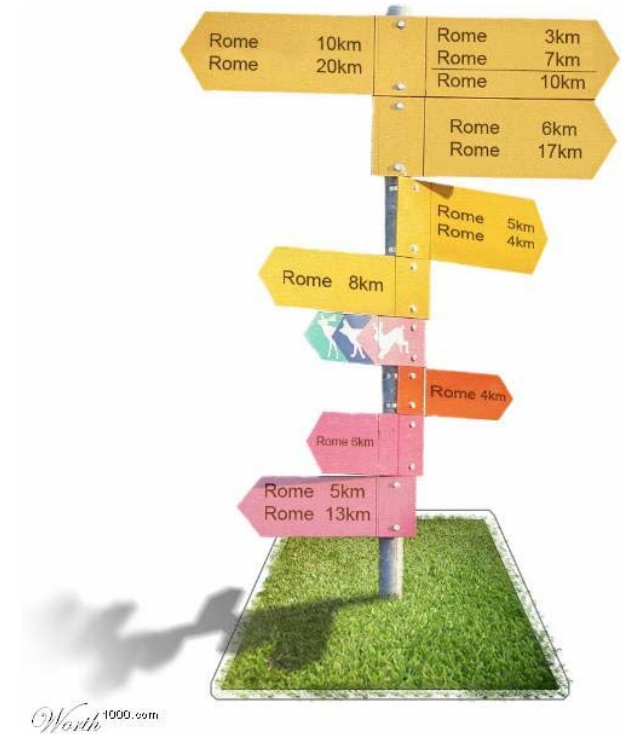


- Do they really have to work this long?



Agenda

- **The Geek Stereotype**
- **Educational Debunk-ments**
 - **Insularity: Collaboration**
 - All roads lead to a pair programming talk
 - **Long Hours: Commitment-making**
 - **Relevance of Field to Society: Project Choice**
- **Summary**



Collaboration: Teacher Survey

- **SIGCSE survey**

- 50 responses

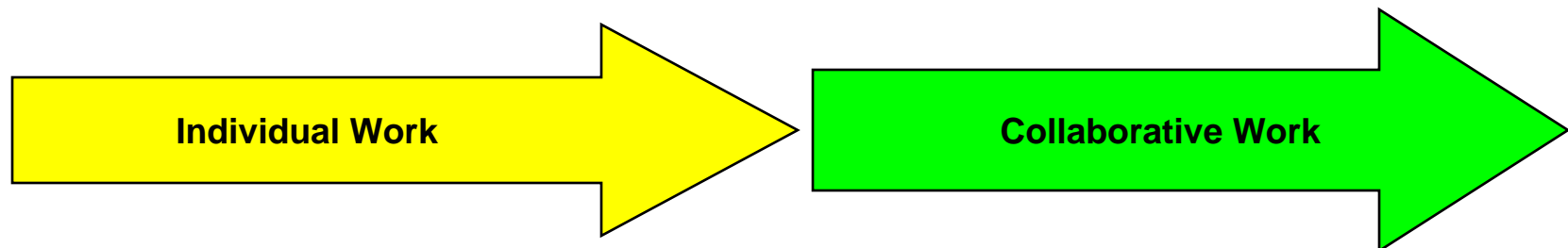
- 17 from Colleges

- 32 from Universities

- 1 from pre-college

- **37 male teachers/professors**

- **13 female teachers/professors**



Benefits Cited

Student Morale

- Helps with anxiety level
- Increases camaraderie in class
- Students feel less alienated
- Reduces frustration
- More supportive study environment



(Not actual student)

Student Performance

- Common goal produces higher achievement
- Improved quality of submissions
- Greater productivity
- Learn better
- Peer pressure enhances effort
- Easier transition to workplace
- Students learn by explaining to others (and work out their errors, clarify concepts)
- Students see a variety of ways to solve a problem
- Develop teamwork skills

Teacher Impact

- Increases size of project that can be tackled
- Less grading
- Less time answering questions about minor issues (Groups can understand while individuals may not)
- Less cheating

Concerns

Competency First

- Want students to gain confidence in their own ability
- Want to make sure students know the fundamentals
- Weaker students do not develop individual skills
- Passive students do not learn

Collaboration Management

- Students get credit for work they may not have done
- Students partition the work and work alone anyway

Compatibility

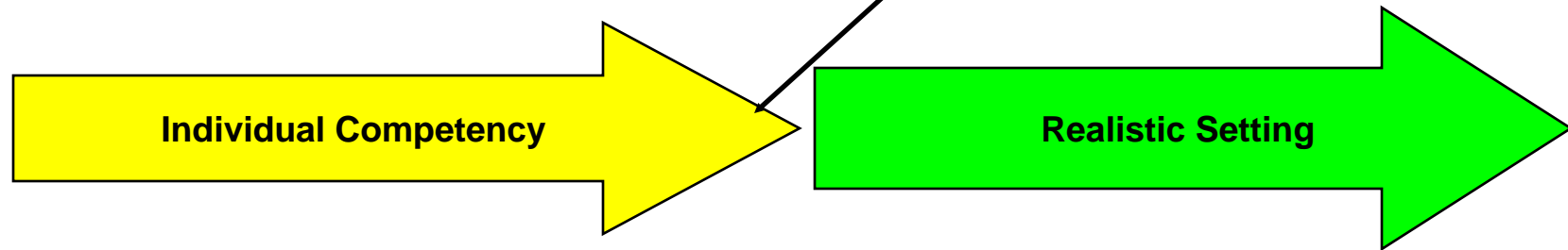
- Stronger students don't want to collaborate with weaker students
- Student backgrounds vary too much

Teacher Workload

- Added time to manage pairs

What about??

➤ Instead of Sequential . . .



➤ Alternate



Pair Programming in an Intro Course

- **North Carolina State University**
 - Fall 2001, Spring 2002, and Fall 2002 → AB-AB-AB
 - 660 engineering students
 - Southeastern US, very large public university
 - Large lecture sections
 - Closed lab
 - Pairs assigned, pair rotation
- **University of California Santa Cruz**
 - Fall 2000, Winter 2001, and Spring 2001 → A-B-A
 - 555 engineering students
 - Western US, large public university
 - Large lecture sections
 - Open lab
 - Pairs by student choice, same partner all semester

Competency First: Success Rate

An equal or higher percentage of students in paired labs will **complete the class with a grade of C or better** compared to solo programmers.

	# Paired	% Pair passing	# Solo	% Solo Passing	Stat. Sign.
NCSU-Sub	171	70.76	255	60.00	Yes. $\chi^2=5.61$, p< 0.023
NCSU-Total	379	64.37	281	59.78	No. $\chi^2=1.45$, p< 0.228
UCSC	404	72.30	148	62.80	Yes. $\chi^2=4.57$, p< 0.05
NCSU+UCSC	783	68.45	439	61.73	Yes. $\chi^2=5.67$, p< 0.017

Competency First: Exam Scores

Students who work in pairs will **earn exam scores equal to or higher** than solo programming students.

	Pair			Solo		
	Mean	Std. Dev.	N	Mean	Std. Dev.	N
NCSU F01	74.1	16.5	44	67.2	18.4	69
NCSU S02a	70.6	28.8	82	73.2	27.4	76
NCSU S02b	71.9	26.7	198	74.9	28.5	26
NCSU-F02	75.1	15.7	55	67.5	35.6	110
UCSC	75.2	18.9	367	74.4	18.5	119

Competency First: Future Success

The use of pair programming in an introductory computer science course **does not hamper student performance in future solo programming courses.**

Semester	Paired (%)	Solo (%)	Statistical Sign
CS1: Fall 2001 – CS2: Spring 2002	21.42 (6/28)	46.15 (12/26)	No. $\chi^2=3.709$, $p<0.054$
CS1: Spring 2002 – CS2: Fall 2002	26.37 (24/91)	29.50 (18/61)	No. $\chi^2=0.179$, $p<0.672$

NCSU: % of students whose grades dropped by more than 1/3 of a grade

	Attempt Rates	Pass Rates (on 1 st attempt) of Attempters
Pair	76.7%	73.6%
Solo	62.2%	72.4%

UCSC: Attempt and Pass Rates for Second CS Class

Aside: Persistence in Computer Science

Students participating in pair programming will be significantly more likely than solo programmers to **pursue computer science-related majors one year later.**

	Paired	Solo	Significance
UCSC	56.9%	33.8%	$\chi^2(1) = 12.18, p < .001$
NCSU	25.6%	10.5%	$\chi^2(1) = 7.434, p < .006$

Percentage of students declaring a Computer Science major 1 year after CS1

Collaboration Management: Pair Evaluation

File Edit View Go Bookmarks Tools Help

http://williams-mpro.csc.ncsu.edu:8980/paireval/main?service=page/Eval

Select the evaluation number: 1

Select your partner be evaluated: Marie Boucher

Has the student attended your group meetings? never

Has the student notified a teammate if he/she would not be able to attend a meeting or fulfill a responsibility? never

Has the student made a serious effort at assigned work before the group meetings? never

Does the student attempt to make contributions in group meetings when he/she can? never

Does the student cooperate with the group effort? never

Assess the technical competency of your partner relative to yourself. Better than me

Assess how compatible you and your partner were. Very Compatible

Overall rating

Excellent Consistently went above and beyond -- tutored teammates, carried more than his/her fair share of the load.

Very Good Consistently did what he/she was supposed to do, very well prepared and cooperative.

Satisfactory Usually did what he/she was supposed to do, acceptable prepared and cooperative.

Ordinary Often did what he/she was supposed to do, minimally prepared and cooperative.

Marginal Sometimes failed to show up or complete assignments, rarely prepared.

Deficient Often failed to show up or complete assignments, rarely prepared.

Unsatisfactory Consistently failed to show up or complete assignments, unprepared.

Superficial Practically no participation.

No show No participation at all.

Comments: no more than 255 characters.

•Peer eval instrument developed by Rich Felder at NCSU.

Teacher Report

(names changed to protect the innocent)

E-Forums Community... multiplayerSTRATEGI... multiplayerSTRATEGI... City of Heroes City of Heroes Officia... City of Heroes Officia... City of Heroes Officia...

Peer Evaluation Report

CSC 326 Section 201 Assignment 3 Review 1

O = Overall Rating
Cty = Compatibility

	Assignment 2 #1			Assignment 3 #1			
	Partner	O	Cty	Partner	O	Cty	Comment
Matt Amyot 201	Will Stufflebeam	8	OK	Will Mason	7	N	ehh. it was ok.
Marie Boucher 201	Frank He	9	Y	Sarah Smith	9	Y	Great partner.
Travis Breaux 201				Adam Smith	9	Y	Great partner to work with
Alex Cau 201	Aaron Pecora	9	Y	Jessie Hunter	9	N	Conflict in schedule
Michael Gegick 201	Lucas Layman	9	Y	Nachi Nagappan	9	Y	
Frank He 201	Marie Boucher	8	OK	Brett Wiley	7	OK	He was alright. On one occasion he did draw the UML at home based on what we agreed the structure would be. On another occasion, he didn't figure out the user input part of the program (we agreed he would cover that, and I would cover some other task).

Done

start Cougar617... ChcluverN... World of W... Pair Eval -- ... Peer Evalua... untitled - Paint 11:15 PM

Collaboration Management: Pair Rotation Research Methodology

➤ **Student Survey**

➤ **CS1**

- at end of course Spring 2003 → N=270
- Four course sections
- Four assignments, new partner after each

➤ **SE**

- post hoc via email from course Fall 2002 → N=17
- One course section
- Four assignments, new one after each
- Six-week team project (4-5 person teams)

Student Results

- **Do you think it was a good idea to change partners after each assignment?**
 - **CS1: 73% yes**
 - **SE: 94% yes**

- **Advantages:**
 - **Exposure to more classmates**
 - **Desire for a new partner**

- **Disadvantages:**
 - **Need to readjust**
 - **Loss of a perfectly-good partner**

Teaching Staff Qualitative Findings

➤ **Advantages**

- Multiple forms of feedback
- Natural handling of dysfunctional pairs

➤ **Disadvantages**

- Reassigning pairs
- Need for peer evaluation (all of pair programming)

Collaboration Management: Compatibility Study Design

- **CS1 (Freshman, Spring 2003, 387 students)**
 - Closed lab
 - Four projects
 - Assigned a new partner each project
- **SE (Junior/Senior, Fall 2002, 140 students)**
 - Closed lab
 - Four projects
 - Assigned a new partner each project
- **OO (Graduate, Fall 2002, 37 pairing students)**
 - No closed lab
 - Pairing optional
 - TA assigned partner

Overall Compatibility Results

Class		Very Compatible	OK	Not Compatible
CS1	1003	63% (633)	26% (264)	11% (106)
SE	496	65% (324)	27% (132)	8% (40)
OO	64	72% (46)	19% (12)	9% (6)

Compatibility Summary

	Hypothesis Pair are more compatible if students with ...	CS1	SE	OO
H-1	... different personality type are grouped together	No	No	No
H-2	... similar actual skill level are grouped together	No	Yes	No
H-3	... similar perceived skill are grouped together	Yes	Yes	Yes
H-4	... similar programming self-esteem are grouped together	No	Yes	No
H-5	... same gender are grouped together	No	No	No
H-6	... similar ethnicity are grouped together	No	No	No
H-7	... similar work ethic are grouped together		No	
H-8	... similar time management are grouped together		No	

Concerns - Reprisal

Competency First

- Want students to gain confidence in their own ability
- Want to make sure students know the fundamentals
- Weaker students don't develop individual skills
- Passive students do not learn

Seems OK

Collaboration Management

- Students get credit for work they may not have done
 - pair evaluation/pair rotation
- Students partition the work and work alone anyway
 - Is this worse (for the students) than solo?

Compatibility → OK 90% of the time

- Stronger students don't want to collaborate with weaker students
- Student backgrounds vary too much

Teacher Workload → offset by less grading, less technical support

- Added time to manage pairs

Commitment-Making: Brooks

*All programmed
sorcery especially
endings and
of nitty frust
habitually fo
that comput
and the you
selection pr
"This time it
bug."*



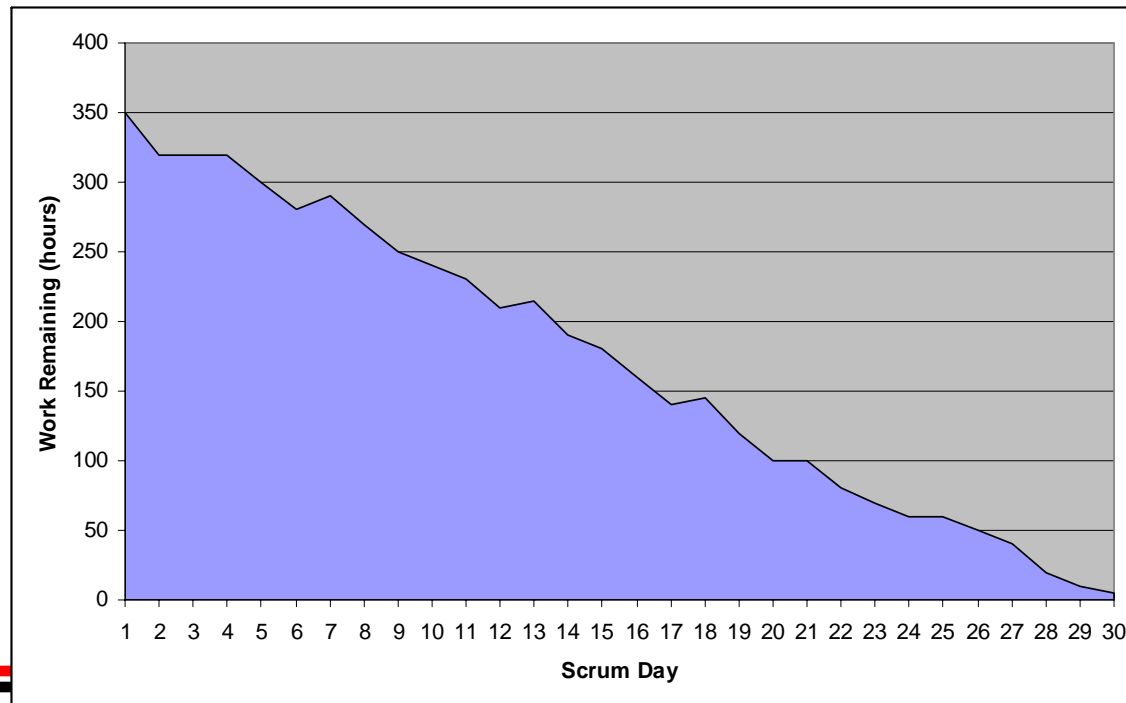
*As this modern
o believe in happy
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it those who
rhaps it is merely
ners are younger,
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st found the last*

- Need “gutless estimating.”
- Stop false scheduling to meet the patron’s desired date
- Need quantitative methods, supported by data, productivity figures, estimating rules, etc.

– Brooks, *Mythical Man Month*

Extreme Programming/SCRUM

- Developer makes estimates
- Estimates do not change as part of choosing stories for iteration
- Energized Work primary practice



Project Choice → Computing with a Purpose

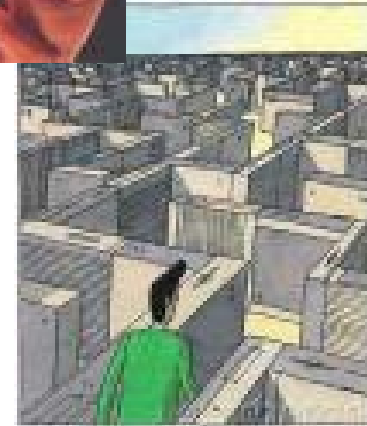
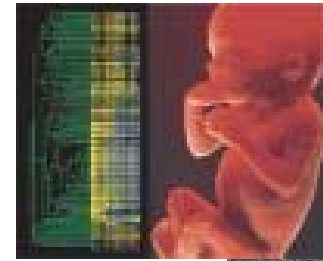
- **Some “just” interested in the thrill of making computers “do things.”**
- **For others (esp. women), the study of computer science is made meaningful by its connections to other fields, working with human and social contexts**
 - **Use computing to study disease**
 - **Robot car that reduces number of accidents causes by human error**
 - **Not sports statistics, number crunching games**
- **“Call It Oceanography and They Will Come”**

Grade my assignments for social relevance

- **Acme Vending Machine**
- **Monopoly game**
- **Pie Throwing Simulation (Abstract Factory Pattern)**
- **Translate hexadecimal to text (Adapter Pattern)**
- **Computer Configurator (Factory Pattern)**
- **Report Generator (Factory Method)**
- **Football Scoreboard (Observer Pattern)**

What's the harm?

It's So Easy.



➤ Bioinformatics, oceanography

- Thrill seekers ☺
- Socially relevant ☺

➤ Aside: industry rounded students



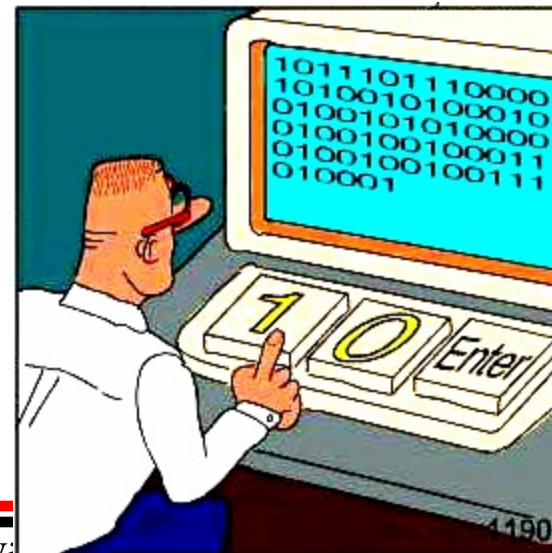
ACME
VENDING

Agenda

- **The Geek Stereotype**
- **Educational Debunk-ments**
- **Summary**

Summary

- The geek stereotype is . . . a stereotype.
- However, computer science education can affirm the stereotype.
- What can be done in education?
 - Add collaborative content
 - Teach commitment-making along with time management, and project management
 - Choose programming projects with social value



Q&A