Benefits of Peer-led Team Learning in CS

Dr. Barbara G. Ryder
J. Byran Maupin Professor of Engineering
Head - Dept. of Computer Science
Virginia Tech

Work at Rutgers in collaboration with Pradip Hari, CS1 coordinator and undergraduate Peer Leaders from AY 2005-2008. Funded by NSF grant ITWF-0420433

Outline

- What is PLTL?
- How program was organized in CS1 at Rutgers (RESCS)?
- Experiences of 8 schools in collaborative NSF grant for PLTL in CS
  - Organization
  - Lessons learned
- What results did we achieve?

  Observations, quantitative and qualitative
- What you need to know to start a PLTL program in CS?
- Summary

What is PLTL?

- Student-led learning groups as integral part of a course
  - Started at CUNY for STEM,
    - http://www.pltl.org/
    - Offer training for faculty in how to use PLTL in class
- Main idea: give students collaborative problem-solving experience, guided by peer mentors
  - Trained peer mentors steer solution process, they are not tutors

Peer Leaders Facilitate

- Help explain the problems to the students
- DO NOT SOLVE THE PROBLEM FOR THE STUDENTS
- Keep the students from taking a long tangent away from a possible solution with a small suggestion
- Draw out the quieter students to give their solution ideas
- Make sure that students take turns at recording the algorithm on the board

Rutgers RESCS Curriculum

- Established Rutgers Emerging Scholars in CS (RESCS)
- Developed new problem solving exercises involving conceptual material from CS1 in Java
- Logical thinking exercises-mostly borrowed
- Games of strategy (e.g., NIM3)
- Typical meeting was 4-5 problems
- Planned extracurricular events
  - Pizza party (social)
  - Career Nights w CS alumni

Sample Exercises

Logic Deduction - Bad Coin Problem

a. Assume that you have 8 coins, and you know that 7 are 'okay' but one is 'bad'. You know that the bad coin has a different weight than the good coins, but you don't know whether it is heavier or lighter. Figure out how, using only a balance scale, you can find out which is the bad coin using just 3 weighings.

(Hint: Find a way to determine that half of the coins are 'okay' with just 1 weighing.)

b. Now do the same thing assuming that you have 9 coins, one of which is bad. (Still use just 3 weighings to find the bad coin.)

c. And now for a real challenge, do the same thing, assuming that you have 13 coins.

Sample Exercises

Using Objects to Simulate Real Life

Think about simulating a car (and its systems) by an object-oriented program. Have one student portray the Car object itself.

Another student should suggest an operation that could be performed on (or by) a car and act it out. Try to think of at least 5 operations for your Car object. Write each operation on the board.

Now think of properties or attributes that a Car object might have. Using post-it notes, label the car with its properties (e.g., color).

Finally, think of sequences of operations that 'test' that your Car runs properly; write them on the board. Did some of your operations require you to define more properties for your Car object?

Sample Exercises

Loops to draw different shapes.

a. Describe a nested loop that will draw a square on output by printing **m** lines of **m** stars (*) on the page.

- Draw a flow chart or pseudo-code of your nested loop.
- Code your loop in Java and run it to see if it 'works'.
- How would the algorithm change if you wanted to draw a 'hollow' square?
- How would the algorithm change if you wanted to draw a rectangle that is **m** by **k** instead of a square?

b. What if you wanted to draw a triangle? How would you have to change the program for a rectangle to draw a triangle?

c. Now consider drawing a circle using a nested loop. How would you do this task? (Hint: you may need to use your knowledge of geometry and some specialized functions in the Java library)

Sample Exercises

Recursion and 2D Arrays

A maze consists of certain types of cells:

0 - *empty cell* is denoted by " . "

1 – *wall cell* is denoted by " * "

2 - *your position* is denoted by " X "

3 - *visited cell* is denoted by " V "

For example, a maze with starting position denoted by "X" can look like this: There are no "island" walls in the maze. Assume we move only up, down, left, right. Write an algorithm to escape the maze.

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. . . . . . . . . .
. * * * * * * . . .
. * . . . . * . * .
. * X * . . * . * .
. * * * . * * . * .
. * . . . . * . * .
. * . * * * * . * .
. * . . . . . . * .
. * * * * * * * * .
. . . . . . . . . .
```

How We Became Involved?

- Formed an 8 school consortium
  - U Wisc (Madison, Milwaukee), Rutgers, GaTech, Duke, Beloit, Loyola (Baltimore), Purdue
- Goal: Attracting and retaining under-represented groups in CS
- 3 year ITWF grant for applying PLTL to CS
  - Funded in Fall 2004 for 4 years
    - U Wisc (Madison) started in Fall 2004, rest of schools one year later

Project Plan

- **Hypothesis:** ***most women and minority students might like CS, if they tried it***
  - Use active recruiting to attract students and peer-led team learning to address their needs
  - Each school uses variations on two themes: active recruiting and peer-led team learning.
    - Different approaches to recruiting
    - Associated with different kinds of intro courses
    - Different team-learning activities
    - Different "extra" activities
- Evaluation for all schools by professional social scientists using surveys and interviews

Coordination

- All PI's encouraged to get PLTL training
  - Sessions held at universities in summer
- Coordination and communication
  - Annual multi-day spring meetings included Peer Leader training sessions (hosted by participating schools)
  - Regular conference calls and e-mail
  - Website for easy sharing of group-learning activities, http://www.pltlcs.org/index.php
  - Developed database of PLTL CS1 exercises grouped by programming language and keywords

Benefits for PLTL Participants

- Better & deeper understanding of material
- Lower drop rates, better grades
- Learn to work together and use everyone's strengths to solve problems
- Learn to see things from different perspectives
- More comfort discussing ideas because of informality and small group size

Special Benefits

- Participants formed natural study groups, for later CS classes
- Had fun learning
- Gained a wonderful new set of friends!

Benefits for Peer Leaders

- Better understanding of the material
- Increased confidence to continue in CS
- Appreciation for different teaching & learning styles
- Improved leadership skills
- Collegial relationship with CS faculty

Benefits for Peer Leaders

- Personal rewards of fostering student learning and of giving back to University community
- Chance to try out educator role to see if it suits them
- Learned to explain new concepts in many ways
- It's fun!

Consortium Report

Susan Horwitz et al, "Using Peer-led Team Learning to Increase Participation and Success of Under-represented Groups in Introductory Computer Science", in the *Proceedings of the SIGCSE Technical Symposium on CS Education*, 2009.

Environment-Rutgers University

- Public Research I university
- State University of New Jersey
  - ~35,000 grad and undergrad students in New Brunswick on multiple campuses
  - ~100 CS majors per year (class of 2008)
- CS in Faculty of Arts and Sciences with B.S. and B.A. degrees
  - 17 courses in B.S., starts with CS1
- Called our PLTL course: Rutgers Emerging Scholars in CS (RESCS)

Rutgers CS1 course

- One intro CS course: *Intro to Computer Science* (in Java) req'd for CS majors and all science/math students
- Lectures (3 hr/wk) & hands-on, programming labs supervised by TAs (1 hr/wk)
- RESCS students took that course plus one session (2 hrs) per week of peer-led team learning
  - RESCS session was P/F, grade based on attendance and participation

Recruitment

- Targeted incoming freshman
  - Presentations at on-campus pre-registration meetings
  - Postcards sent to home addresses
  - Follow-up emails
  - Worked with advisors and minority counselors to suggest program participation, especially Dean of freshmen
  - Webpage
  - In-class recruiting

Recruitment

- Peer Leaders
  - Solicited from among good students in class in previous term(s)
  - Trained peer leaders through annual workshop and weekly meetings with instructors
  - Always gave peer leaders questions and worked out answers

Administrative Details

- Worked with deans and scheduling to obtain conference room setting for sessions
- DCS Associate Chair allowed RESCS to be 1 credit P/F independent study w Ryder
  - Grade decoupled from CS1 course; based solely on attendance and participation in sessions
- Obtained DCS buy-in from Dept Chair, Associate Chair, Deans in Office of Undergrad Academic Affairs
- Reporting participation with Registrar's support; needed EEOC categories on students

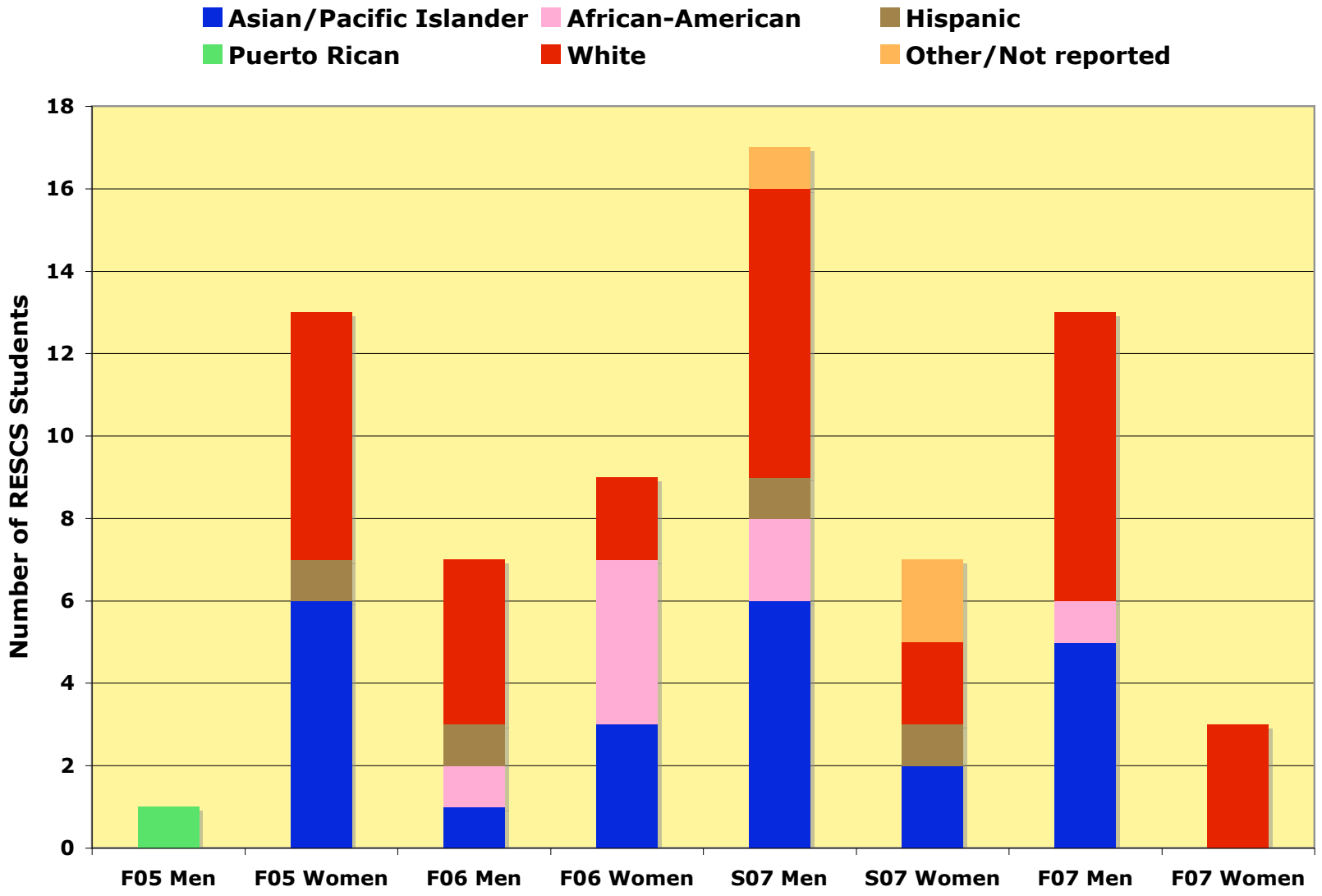
Adding Value to DCS

- Peer leaders chosen primarily from target population
  - Leadership and personal growth opportunity
  - Allowed exploration of an educational career
- Career Nights
  - Recent DCS Alumni returned to campus to talk about their experiences
  - Every term, well attended by 30-40 students
  - Evening event proceeded by pizza/soda
  - Recording of audio available afterwards on Web

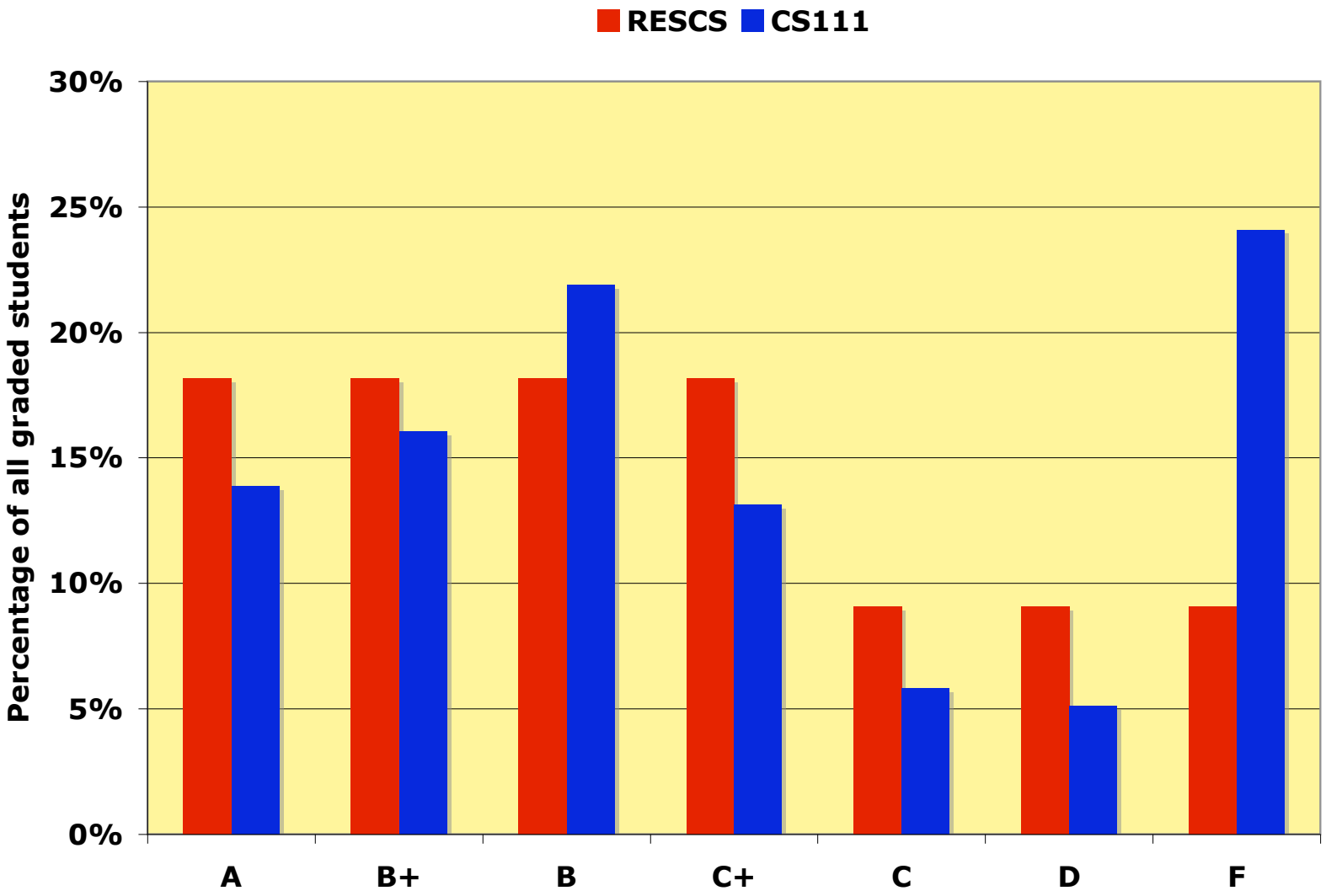
Observations

- Quantitative data for Rutgers alone often was not sufficient for statistically significant conclusions
  - RESCS often has lower drop rate than CS1
  - RESCS overall has shift to higher grades over CS1, although some RESCS students receive F's
- Data from entry/exit surveys showed
  - RESCS was considered helpful by students
  - Students seemed to gain confidence in programming Java and understanding Java programs through RESCS
  - Students enjoyed the RESCS type of learning environment

Gender and Ethnicity of Participants

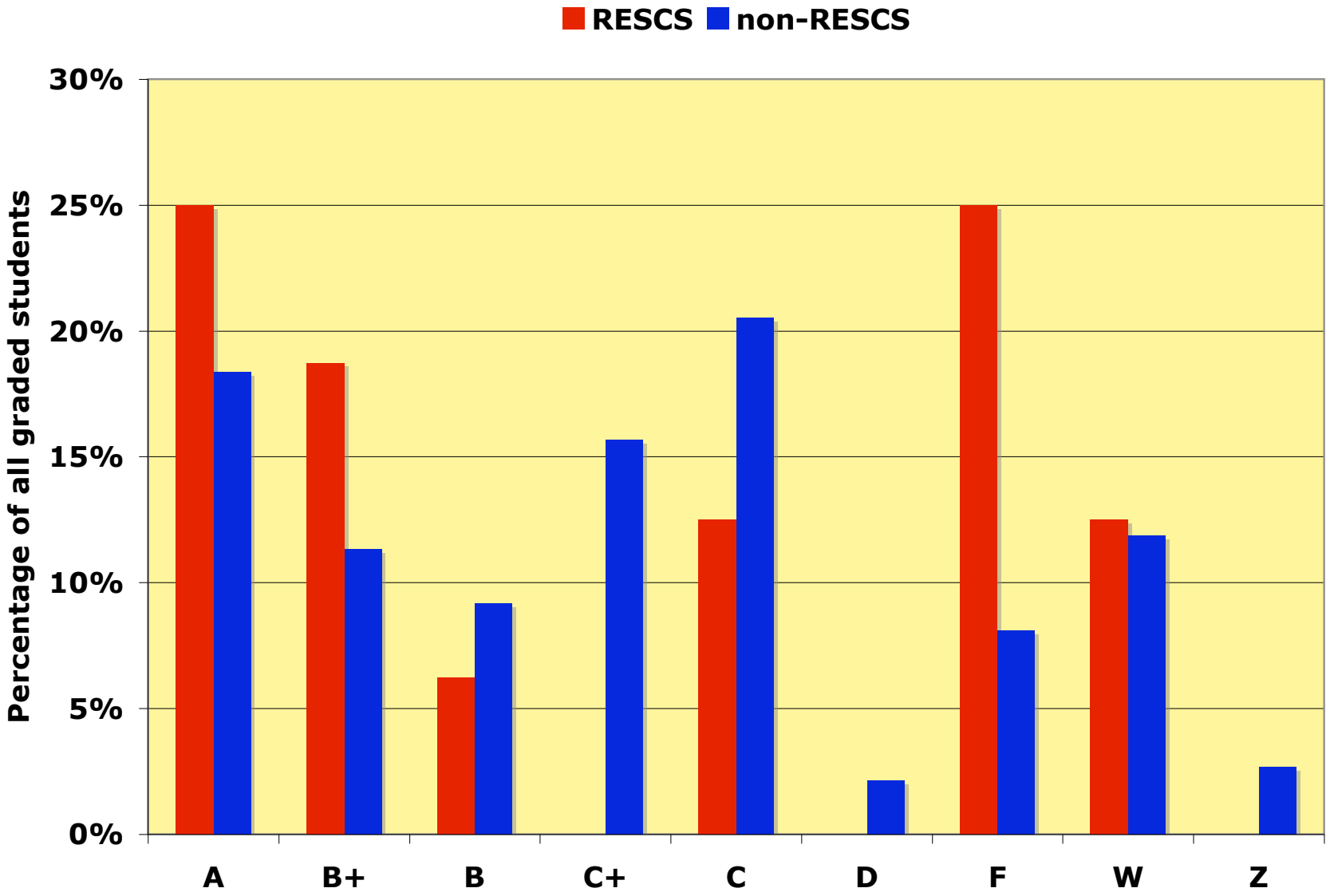


Grades: RESCS vs non-RESCS



Fall 2005

Grades: RESCS vs non-RESCS



Fall 2006

Measures of Success for Entire Grant Population

- Higher grades & Lower drop rates than non-PLTL students (stat.sig.)
  - Even better grades results for female students
- Increased interest in computer science for participants and Peer Leaders
- Enrollment in additional CS courses
- Attitudinal changes measured in the surveys

Participant Comments

- *This class was awesome, because the informal setting allowed me to participate actively, and actually enjoy computer science.*
- *I thought this course was very beneficial to my learning of java, especially since I had never programmed before in any language.*
- *The stuff we did was cool and I learned a lot!!!*
- *This class is very helpful. I am doing better in CS 111 because of it*
- *Today's exercises were hard, but interesting. I enjoyed playing NIM3 and the magic squares were very complicated.*
- *I really liked today's exercises because they reinforced what we did in class. They were good practice, and had a little twist to them.*

Survey Feedback

- *Why enroll in CS1 & RESCS?*
  - Women
    - Wanted to see if they enjoyed programming or CS
    - Responded to email invitation
    - Because of parental advice
  - Men
    - Course was required for major
    - Already interested in being CS/CE major

Survey Feedback

- *Why RESCS students did not major in CS?*
  - Don't want to sit in front of a computer all day
  - Had decided before taking CS1 on another major
  - Programming isn't 'thrilling'
  - Want to work with people

Survey Feedback

- F2006:
  - Some indication that RESCS students entered with slightly less confidence to perform Java programming tasks and gained more perceived ability…compared to the non-RESCS students.
  - 40% RESCS students expressed concern about outsourcing
- S2007:
  - Self-perceived ability to read a Java program (stat. sig)
  - RESCS students showed significant increase in being comfortable about asking another student for help
  - RESCS students showed strong agreement that working in teams has benefits over working individually

Since Spring 2008….

- Starting in Fall 2008
  - Offered RESCS as recitation mode in CS1 course to ALL students
    - Group learning seems to support students across the 'talent divide' well
    - Use of peer leaders was welcomed by students and worked well
    - Challenge getting/training enough undergrad peer leaders (between 11-32 per semester w 3-10 students per group)
  - Positive outcome
    - "*Created CS community that undergrads wanted to be a part of*"
    - "*improved the atmosphere of our undergrad program*"
    - Were able to get 3 hours/week/per peer leader funding from Dean

How to Start a PLTL Program: Critical Components

- Admin support
  - $$ for peer-leader salaries
  - "Credit" for program supervisor
- Course instructor closely involved
  - Reviews materials, suggests topics & problems
  - Attends weekly meetings, mentors peer leaders
- Need appropriate physical environment
  - Not desks in rows!

Critical Components

- Trained and closely supervised leaders
  - Pre-semester training
  - Weekly meetings
  - Meeting feedback from students
- Small groups (5-8 students);attendance required
- Appropriate materials
  - Good fit with course material; relevant!
  - Engaging; appropriately challenging
  - Variety of styles
  - Suitable for groups

Summary

- RESCS, an experiment with PLTL in CS that continues…
  - Aimed at underrepresented groups
    - Somewhat successful in attracting target population
    - Need to attract more women both to CS1 and to RESCS
  - Considered useful by students who participated
  - Survey results, drop rates, and grades difficult to interpret, due to small numbers of students
    - Could only get info over aggregate of all participants
  - We are convinced the program is a good pedagogical tool, but not sufficient to address the underrepresentation problem

Questions?