Research Supporting Best Practices for Women in Science

Laura McCullough
UW-Stout
Physics Department

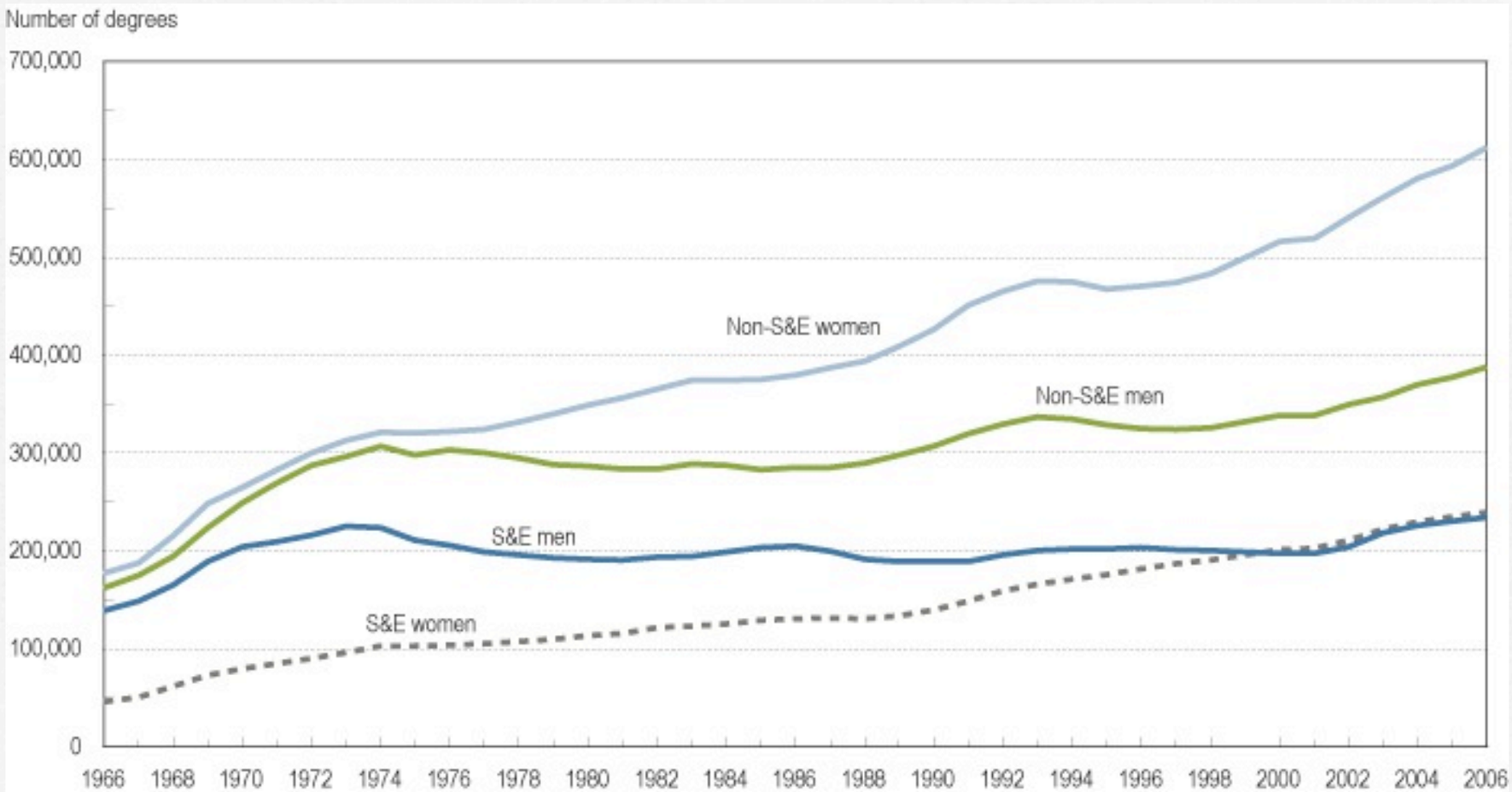
Outline

- [ ] Is there inequity?
- [ ] Is inequity an issue?
- [ ] What can be done about it?

The call for more women in science

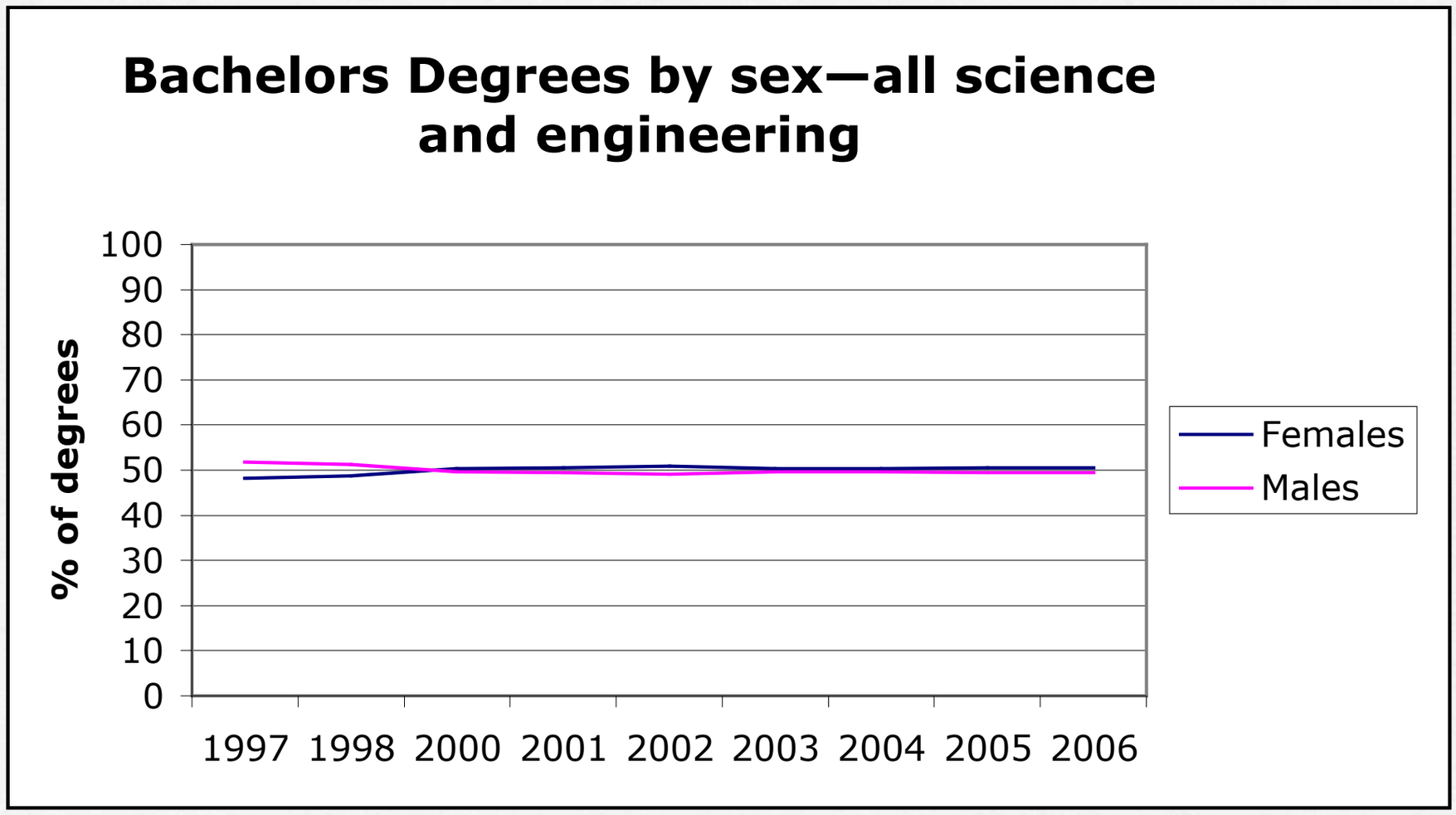
- Several reports have emphasized the need for increasing the participation of women and minorities in STEM fields. (economic & scientific advantage; Title IX)
- NAS Rising Above the Gathering Storm 2005
- Getting Girls to the Lab Bench. By: Arnst, Catherine, Business Week, 00077135, 2/7/2005, Issue 3919

Is this really a problem?

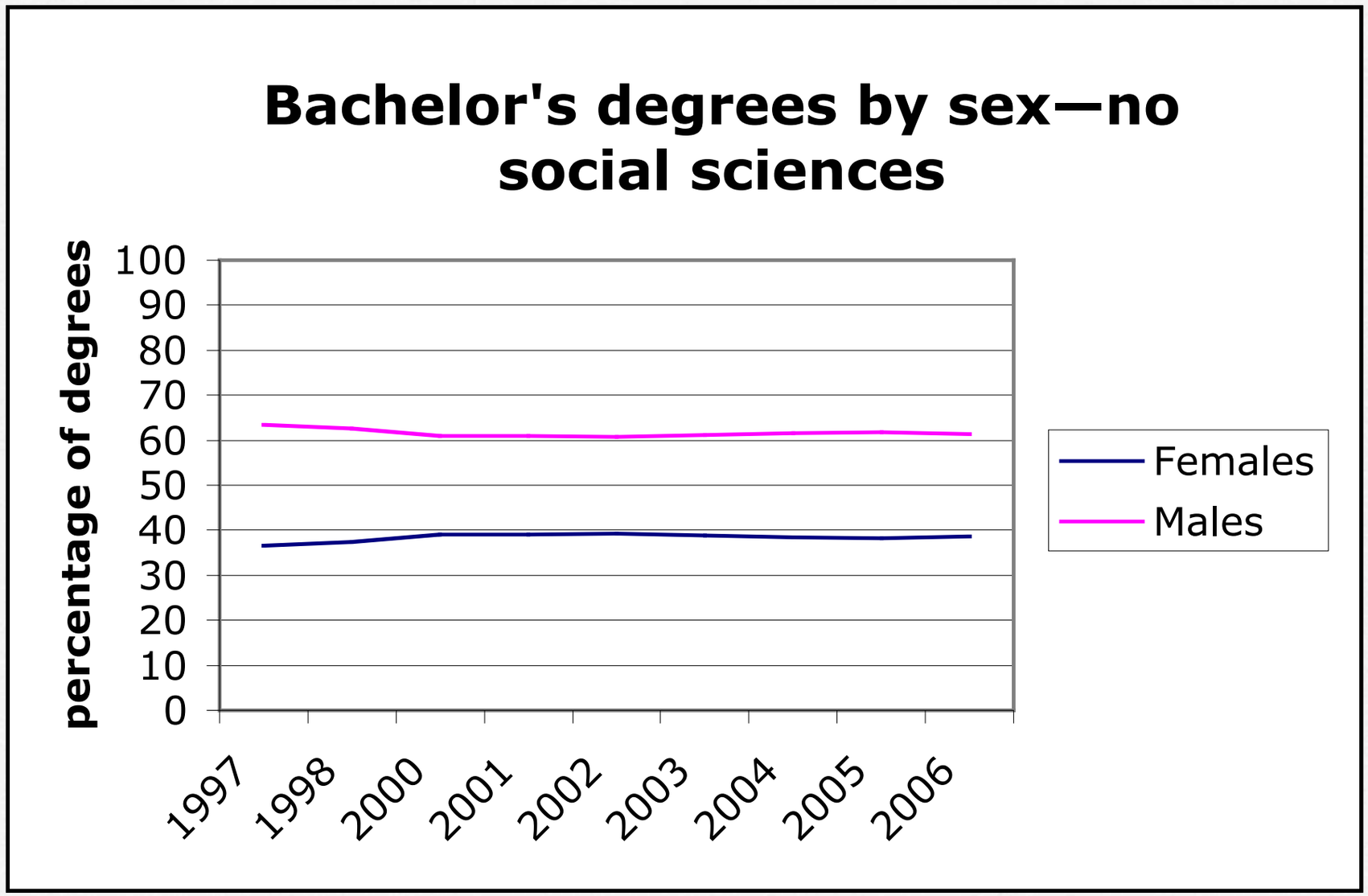


From NSF Women & Minorities report 2009

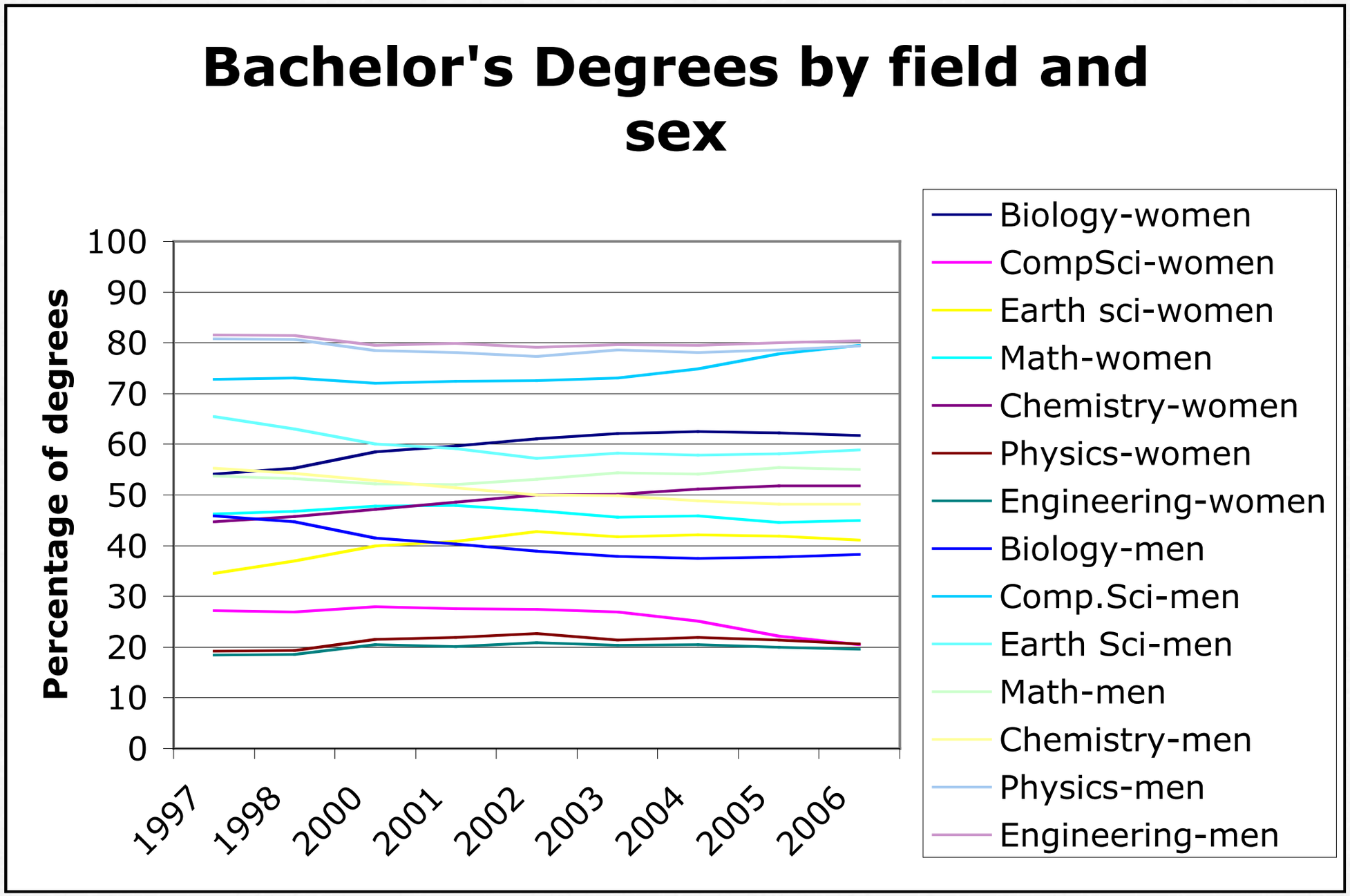
Bachelors degrees by sex



Removing the social sciences...



Bachelors degrees by field and sex



There is inequity!

- Women underrepresented in STEM overall, in some fields severely underrepresented
- Need to work on increasing representation in some fields

Is inequity a problem?

- Fewer women = problem?
- How do we know there's a problem?
- What if women don't want to go into science?
- Don't force women into a field!

Arguments for change

- Inequity is a problem:
  - sexual discrimination
  - sexual harassment
  - discouraging remarks
  - bad advising
  - interested women still leaving

Bad pedagogy

- "Reports of poor teaching in S.M.E. classes were by far the most common complaint of all switchers and non-switchers."

  Pedagogy was third-highest rated reason for leaving science

- Science teachers less likely to use active learning techniques; more likely to grade on curve

Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences.* Boulder, CO: Westview Press.

Milem, J., & Astin, H. (1994). *Scientists as teachers: A look at their culture, their roles, and their pedagogy.* Paper presented at the NARST meeting, New Orleans, LA.

High school pedagogy

- Deep and narrow pedagogy in high school helps achievement in college physics courses
- No mention if it helps females more

Tai, R. and Sadler, P. (2001). Gender differences in introductory undergraduate physics performance; university physics versus college physics in the USA. *Int'l J. of Science Education*, 23(10), 1017-1037.

Pedagogy to attract

- What Works? project:
  More than one student cited an innovative teaching approach as a reason to major in physics
- Grinnell College: Changing pedagogy in intro courses draws more women

Whitten, B., S. Foster, M. Duncombe, P. Allen, P. Heron, H. Zorn, L. McCullough, K. Shaw, B. Taylor. (2003) What Works? Increasing the Participation of Women in Undergraduate Physics. J. of Women and Minorities in Science and Engineering, 9(3/4), 239-258.

Schneider, M. (2001). Encouragement of women physics majors at Grinnell College: A case study. Phys. Teacher, 39, 280-282.

Pedagogy to retain

- Rutgers University:
  "Extended General Physics" course with more interactive pedagogy helps women stay in the course; 1% drop compared with 11% drop in regular course

- "Individual differences between students far outweighed gender differences"

Etkina, E., K. Gibbons, B. L. Holton, G. K. Horton. (1999). Lessons learned: A case study of an integrated way of teaching introductory physics to at-risk students at Rutgers University. Am. J. of Phys., 67(9), 810-818.

Pedagogy helping women?

- Workshop Physics:

  Younger college women → positive experience

  More senior college women → more likely to feel negative about the interactive course structure

- SCALE-UP:

  Women were almost five times as likely to pass a SCALE-UP course than a traditional course

Laws, P., P. Rosborough, F. Poodry, (1999). Women's responses to an activity-based introductory physics program. Am. J. of Phys., 67(7), S32-S37.

Beichner, R., J. Saul. (2003). Introduction to the SCALE-UP Project. Paper submitted to the Proceedings of the International School of Physics, Varenna, Italy.

Pedagogy and attitude

- Feminist pedagogy in physics classroom showed large positive changes in attitude (men and women)
- "Almost significant" effects on student anxiety (reduction of anxiety)

Davis, F. & Steiger, A. (1993). *Feminist Pedagogy in the Physical Sciences.* Report to the Quebec Department of Higher Education and Science.

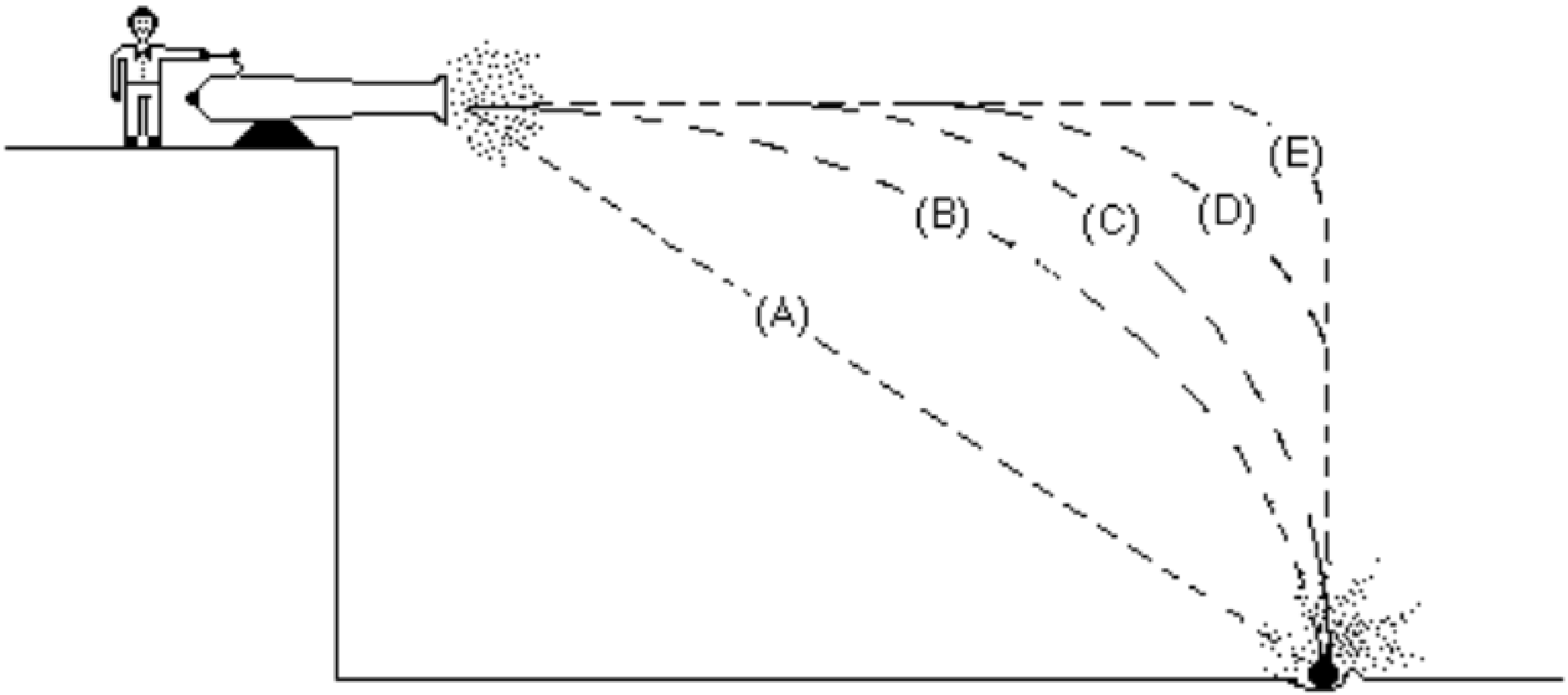
Interactive Engagement @ Harvard

- FCI: Consistent pretest gender gap every year

Lorenzo, M., C. Crouch, E. Mazur, (2006) Reducing the gender gap in the physics classroom. Am. J. of Phys., 74(2), 118-122.

Original FCI Question #12

12. A ball is fired by a cannon from the top of a cliff as shown in the figure below. Which of the paths would the cannon ball most closely follow?



Interactive Engagement @ Harvard

- FCI: Consistent pretest gender gap every year
- Traditional pedagogy: post-test gender gap
- First implementation IE course: reduced gender gap post-instruction
- Second implementation IE course: gender gap post-instruction reduced to statistical insignificance

Lorenzo, M., C. Crouch, E. Mazur, (2006) Reducing the gender gap in the physics classroom. Am. J. of Phys., 74(2), 118-122.

Lorenzo et al. continued

- FCI normalized gain <g>
- More interactive course increased gain for both men and women
- Gender gap in <g> reduced to insignificance with more interactive course

Lorenzo et al. continued

- Reduced gender gap attributed to pedagogical changes (pretest constant)
- "No observed loss of achievement among the male students."

Pedagogical changes can help

- Pedagogical changes can help create more welcoming environments for women
- But what kind of changes?

Pedagogical strategies

- Pedagogical strategies that help:
  - collaborative learning environments
  - cooperative learning environments
  - respectful learning environments
  - teacher-student connections

Pedagogical Strategies

- clickers/student response systems
- connections to applications
- respect for diverse opinions

Pedagogical strategies

- Survey of science teachers' memorable science teachers; collaborative/cooperative classrooms; respect; diverse opinions; connections; activity-based instruction

Taylor, Marilyn J.; Swetnam, Leslie A.; Friot, F. Elizabeth. Clearing House, V73 n1 p33-36 Sep-Oct 1999

Making connections

- Carleton College: close collaboration with professors produces high number of women earning advanced degrees in science

Chronicle of Higher Education; 5/5/2006, Vol. 52 Issue 35, pA12-A14, 3p

Institute of Education Sciences

- 5 strategies for young women:
  - teach that academic skills are improvable
  - prescriptive, informational feedback
  - role models
  - classroom environment sparks curiosity and life long interest in STEM
  - spatial skills training

Halpern, D., Aronson, J., Reimer, N., Simpkins, S., Star, J., and Wentzel, K. (2007). Encouraging Girls in Math and Science (NCER 2007-2003). Washington, DC: National Center for Education Research, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ncer.ed.gov.

Clickers/SRS

- All students using clickers scored higher than non-users; male effect was stronger than for females

http://www.vanderbilt.edu/cft/resources/teaching_resources/technology/crs_biblio.htm

King, D. B., & Joshi, S. (2008). Gender differences in the use and effectiveness of personal response devices. Journal of Science Education and Technology, "Online First" edition.

Other strategies

- Non-pedagogical strategies proven to help:
  - Role models
  - Peer & family support
  - Mentoring/advising

Role models

- Schools with higher % female faculty have higher % female graduates
- Role models have strong influence on women scientists
- Older study suggesting no support for role models' importance

Sonnert, Gerhard; Fox, Mary Frank; Adkins, Kristen. Social Science Quarterly (Blackwell Publishing Limited), Dec2007, Vol. 88 Issue 5, p1333-1356
Downing, Roberta A.; Crosby, Faye J.; Blake-Beard, Stacy. Psychology of Women Quarterly, Dec2005, Vol. 29 Issue 4, p419-426
Verrall, Maggie. Nature, 7/14/94, Vol. 370 Issue 6485, p88

Peer & family support

- Stronger family resources more likely for young women interested in science
- Female STEM majors feel less support and respect from peers
- Parental views on science have strong effect on their children's views

Hanson, S. (2000) Gender, families, and science: Influences on early science training and career choices. Journal of Family Issues, Jan96, Vol. 17 Issue 1, p83

Hughes (2000). Perceived gender interaction and course confidence among undergraduate science, mathematics, and technology majors. Journal of Women and Minorities in Science and Engineering, 6(2) p155.

Byler (2000). Middle school girls' attitudes towards math and science: Does the setting make a difference? Dissertation, UCLA.

Mentors

- Mentors are important for women scientists (male and female mentors)
- MENTORNET.net

Downing, Roberta A.; Crosby, Faye J.; Blake-Beard, Stacy. Psychology of Women Quarterly, Dec2005, Vol. 29 Issue 4, p419-426

Summary

- Inequity exists and is a problem
- Interactive pedagogies can help both women and men students
- Some evidence that interactive pedagogies help close the gender gap
- Other strategies outside the classroom also help improve women's participation