Derek Bok Center for Teaching and Learning

Harvard University DEPARTMENT OF PHYSICS

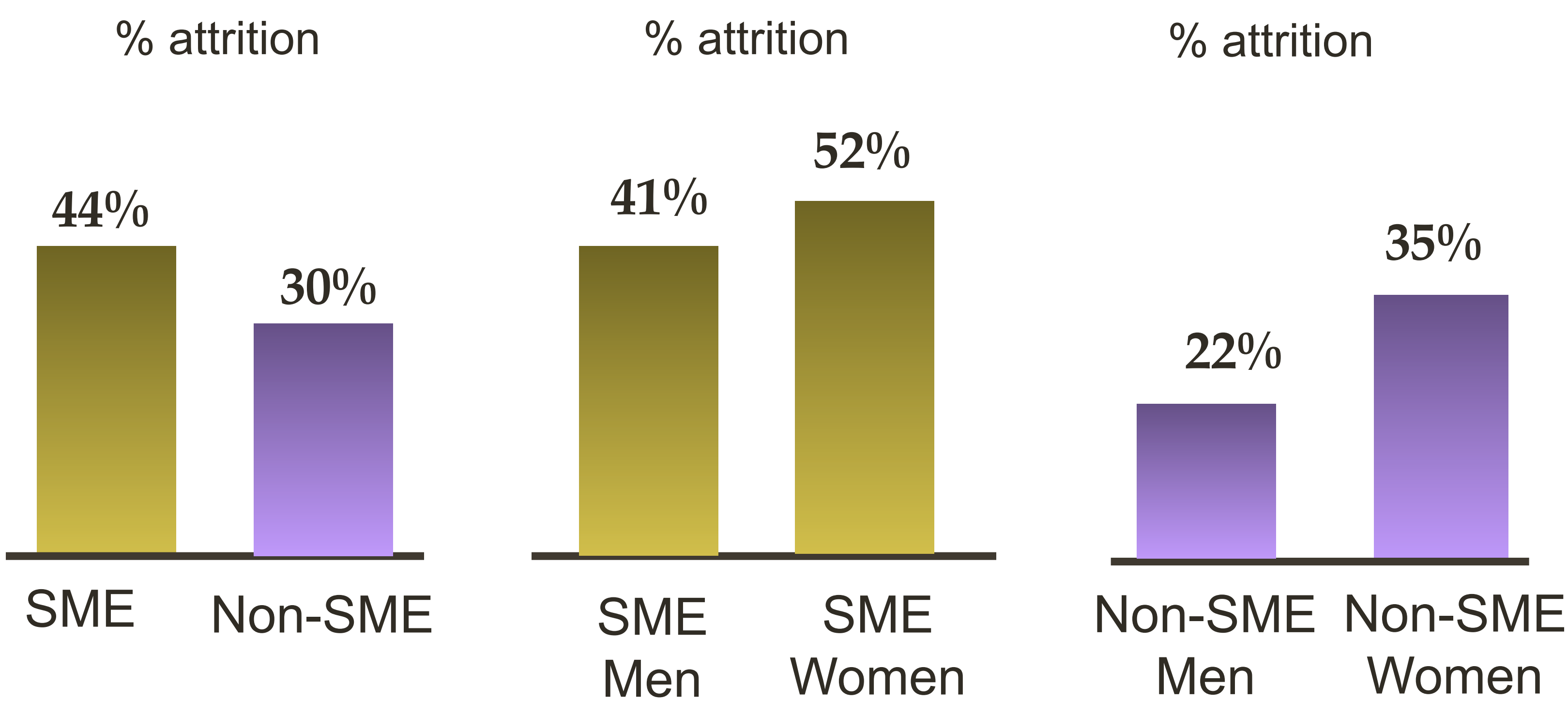
Learning and Retention in STEM Courses: Harvard's experience

John Girash & Rachael Lancor

Harvard University

Council of Graduate Schools Summer Workshop
July 10, 2012

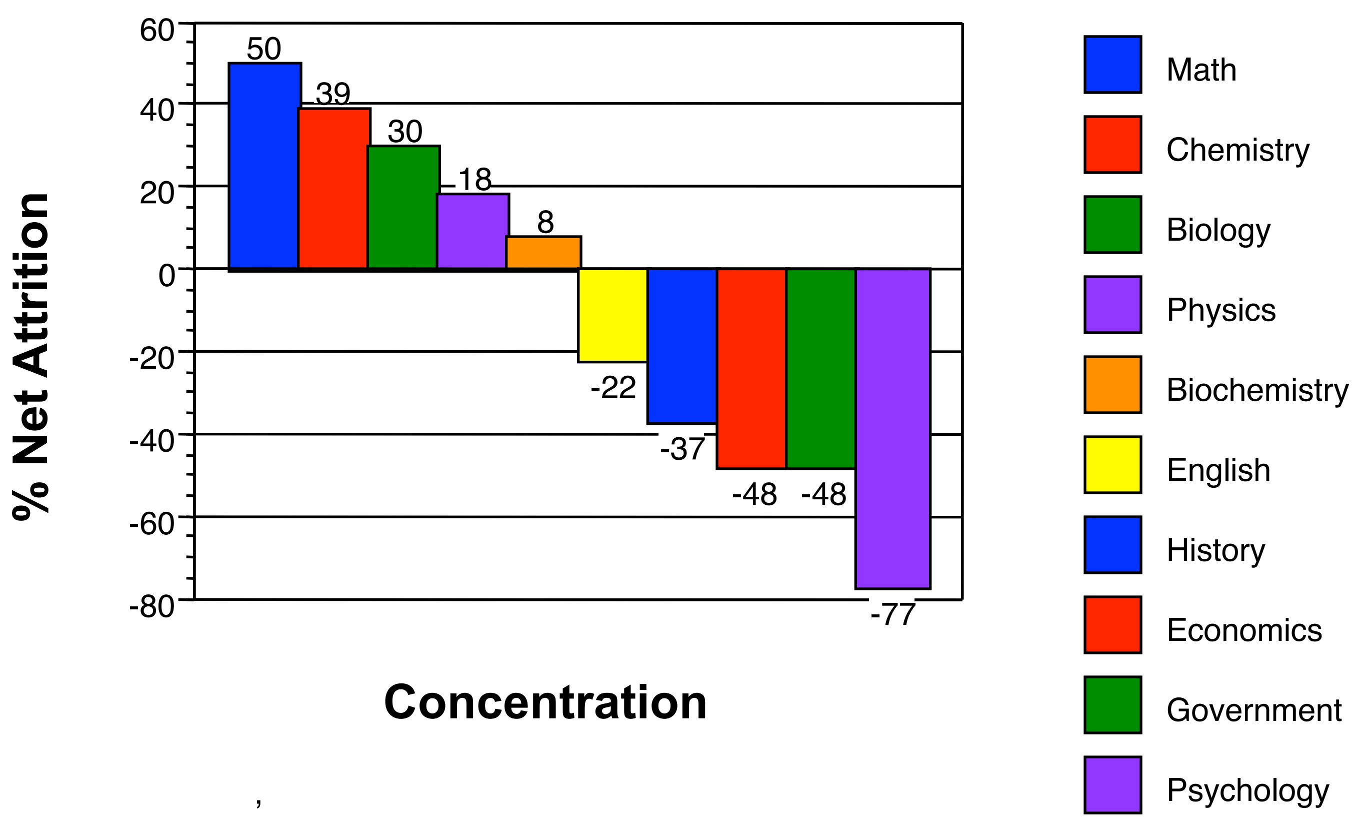
Problems with Retention: Attrition is disproportionately high in the sciences and high among women[1]



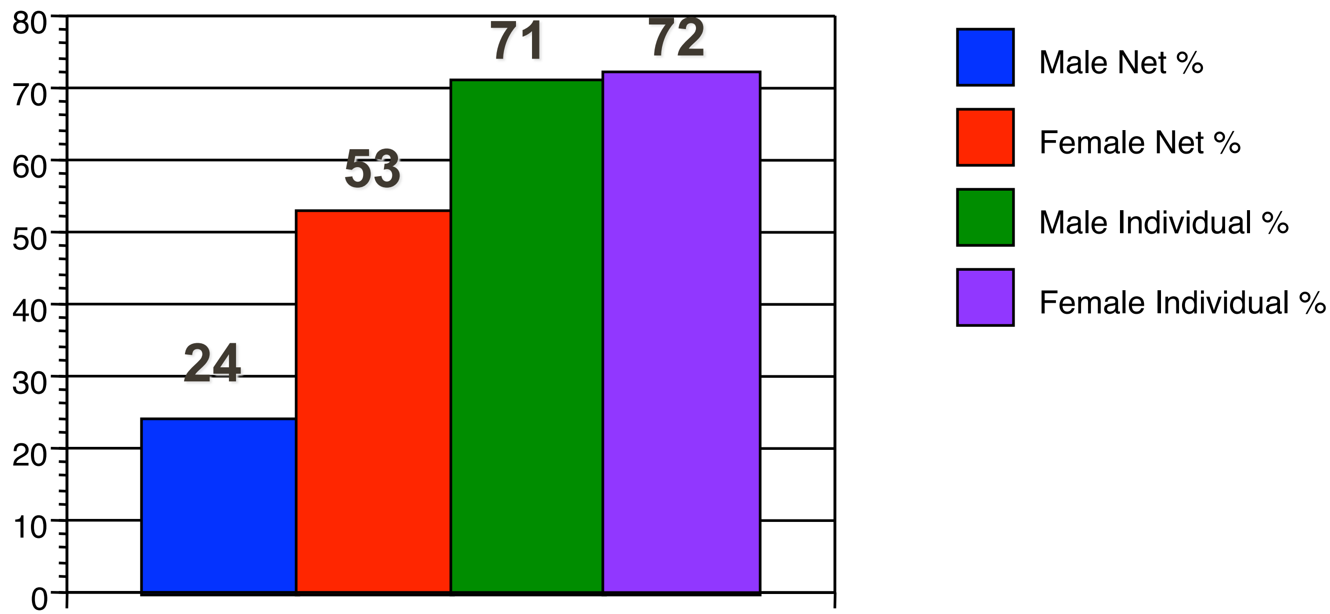
[1]Seymour, E., & N. M. Hewitt, 1997. *Talking About Leaving: Why Undergraduates Leave the Sciences*. Boulder, CO: Westview Press.

Bok Center / Harvard Chemistry study: High Net Attrition in Traditional Sciences

[Jay Deiner, 2005]



High Net Attrition for Women in Chemistry *but* Comparable Individual Attrition



Chemistry has fewer women because it attracts fewer women after matriculation, not because it loses more

Experiences of female concentrators vs. non-concentrators are more different than are those of male counterparts

Males	Females
Concentrators / Non-Concentrators	Concentrators / Non-Concentrators
8 Significant Differences	**16 Significant Differences**

All of the unique significant differences between female concentrators and non-concentrators relate to perceptions of chemistry culture

Peers value contributions
Quality of teaching
Competitiveness
Faculty encouraging

Faculty approachable
Faculty available
Work with study groups
Feel comfortable participating

Recommendations of Bok Center / Chemistry study

➢ ***First course is key. Collaborative and smaller classes may help.***

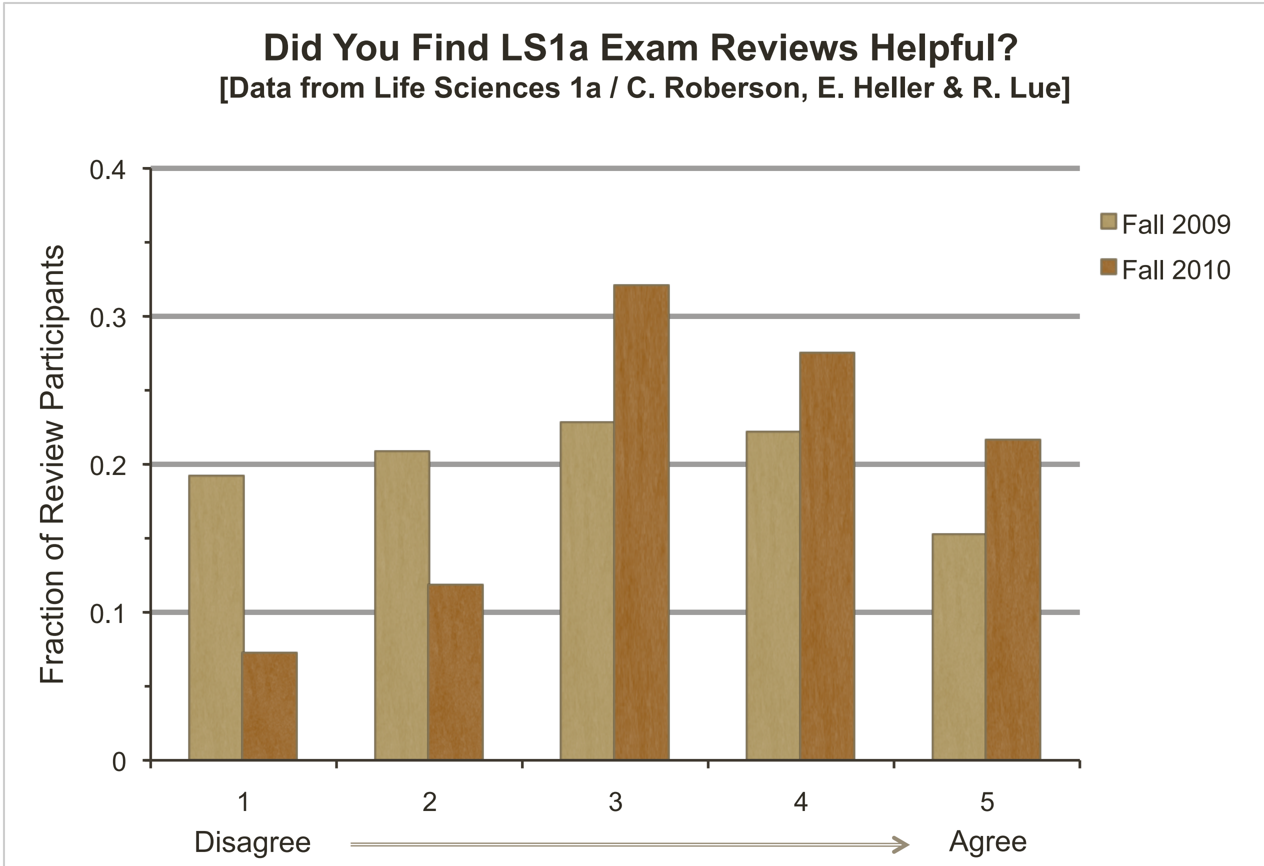
New curriculum, new hiring, new mechanisms

- Still large, but **integrated introductory Life Sciences** courses (and later, integrated Physical Sciences courses) leading to science majors
- Dean-led all-stakeholder **oversight committee** for initial courses
- Hiring of Preceptors and Directors as **faculty-level expert teachers**
- Faculty rededicated to **teaching labs** as integral aspect of courses

---

➢ ***Student success correlates with how positively they view courses. Keep courses challenging but delineate clear and attainable paths to success. Provide for modes of self-assessment.***

- Large commitment to in-course and general-undergraduate **advising**
- Try out, and evaluate effectiveness of, various **support mechanisms** (e.g. organized peer study groups in LS1a; tried, not needed in 1b)
- *Life & Physical Sciences A* for students needing **alternative entry point**



Format of Exam Reviews for Fall 2009 (and prior): More Teacher-Centric, Passive, Large-Group.
TFs stand at front of large lecture hall and either show Powerpoint slides of key concepts to the entire group, or go over a practice exam with students. Students are encouraged to interrupt to ask questions at any time.

Format of Exam Reviews for Fall 2010 (and thereafter): More Student-Centric, Active, Small Groups.
TFs are available in a large non-lecture hall room and distribute at different "stations", where students can congregate in smaller groups to ask questions about material. There are no formal presentations to the entire group.

Grad Student Training

- Teaching practicum courses for grad students
- Physics 302: Teaching & Communicating Physics
  - Practice teaching sessions
  - Pedagogy – student centered approaches to learning, facilitating discussions, questioning strategies, inquiry-based labs
  - Learning theory –science education research
- Bok Center's Course of the Future "Teagle" Seminar and Certificate Program

7 Best Practices

* Good practice in undergraduate education:
    * encourages contact between students and faculty,
    * develops reciprocity and cooperation among students,
    * encourages active learning,
    * gives prompt feedback,
    * emphasizes time on task,
    * communicates high expectations, and
    * respects diverse talents and ways of learning.

Chickering & Gamson (1987)

How do we do this?

* By continuously assessing what our students are thinking!

* Formative assessment
  * Continuous assessment in the classroom
  * Clickers, short writing assignments, concept questions, one minute papers

Assessment

- Before you decide how to assess your students, you need to decide what to assess
  - Content, skills, applications

- Summative assessment
  - More than just multiple choice exams!
  - Projects, papers, presentations

Research-based Principles for Reform

- Set clear and obtainable learning objectives
- Decide how you want to assess the objectives
- Design the course so that students can be successful on the assessment

Wiggins. (2001) *Understanding by Design*.

More curriculum development

* Physical Sciences 2 & 3
  * Introductory physics for life science (pre-med) students
  * Integrates biological examples in with the physics content, cut irrelevant topics (e.g., gravitation)
    * Ex: Modeling neurons with circuits