University of Massachusetts, Amherst
TWIST Research Committee Report #1

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Executive Summary. We have analyzed the retention of women and men in science, technology, engineering and math (STEM) majors here at UMass, and at comparable institutions across the nation, to determine if women are leaving STEM majors at disproportionately large rates. In general, we have found that *the retention and graduation rates of women in STEM majors are superior to those of men.* This finding holds here at UMass, and at comparable institutions as well. Despite these larger retention and graduation rates for women, more men graduate from most STEM majors. This study suggests that new academic policies for approaching gender equity in numbers of STEM graduates should not focus on college retention issues, but rather on increasing the number of women entering college with interests in STEM fields. Such changes will likely take place at the middle school and/or high school levels.

Objective. The fact that women are under-represented in the science, technology, engineering and math (STEM) work force is generally well known. To address this problem, TWIST has formed at UMass with the following three-fold mission:

- To attract more women to STEM majors at UMass,
- To retain more women in STEM majors, and
- To support the success of women in STEM careers.

To better understand the problems inherent in each of these three areas, and the interactions among them, we will seek out and/or perform research that quantifies the demographics of women in various stages of STEM education and careers. This will provide baselines for determining the success of TWIST initiatives at UMass, and will help identify the particularly problematic areas for women at UMass pursuing education in STEM.

To begin, the TWIST steering committee decided to focus on quantifying undergraduate retention rates for women and men in STEM majors, to determine if women are leaving STEM majors at disproportionately large rates. Although our ultimate goal involves understanding retention trends at UMass, we need to understand these trends by comparing UMass retention rates with those from comparable institutions across the nation. If women are indeed leaving certain STEM majors at disproportionately large rates, we seek to determine:

- Which majors produce the most dramatic attrition for women in STEM?
- When in the undergraduate career is attrition from these majors most likely?

Below we discuss the sources of data, results and conclusions for this study of undergraduate retention rates for STEM majors.

Approach. We seek to quantify retention of women and men in STEM majors at comparable institutions across the nation, here at UMass as a whole, and in individual

STEM majors at UMass. We began by studying a recent National Science Foundation (NSF) report (http://www.nsf.gov/sbe/srs/nsf99338/) published in 1999, with data spanning the years 1966-1995.[1] Although this report provides a wealth of information on the *production* of undergraduate degrees earned by women and men in STEM majors, it says nothing about *retention per se*. In addition, the NSF report often lumps many majors into groupings (e.g. physical sciences), while we seek department-specific data. Nonetheless, there are still interesting lessons to be learned from this NSF study.

National and UMass retention data were made available to TWIST by the UMass Office of Institutional Research (http://www.umass.edu/oapa/oirfiles/oirindex.html) (OIR). The UMass OIR participated in a retention study initiated at the University of Oklahoma, in which retention and graduation rates were tracked from 1992 to 1998 for three groups of students:

1. Students who begin their first year of college with a declared major.
2. Students who begin their first year of college with an STEM major.
3. Students who begin their first year of college with an STEM major, and either continue with their initial major or change to another STEM major.

These retention data, especially those in Section 3, reveal interesting trends for TWIST. However, these data were not reported for each department separately because of statistical problems associated with departments with relatively small numbers of majors. For future research TWIST and OIR plan to collaborate to produce these departmental retention breakdowns, despite the possibility of statistical difficulties.

Finally, statistics were obtained on the success of women and men in passing the two introductory Chemistry courses for STEM majors, Chem 111 and Chem 112, for three academic years: Fall 1997–Spring 1998, Fall 1998–Spring 1999, and Fall 1999–Spring 2000. The populations in these courses, particularly Chem 111, represent nearly all the students who begin their first year of college with an STEM major. As such, these Chemistry data provide a glimpse into the early academic pursuits of women and men STEM majors.

Results.

NSF Report: The NSF report provides the following U.S. population statistics for 1995:

	Population	Workforce (Age 20+)	STEM Workforce (Age 20+)
Women	51.1%	45.9%	22.4%
Men	48.9%	54.1%	77.6%

Table 1. Overall population statistics.

Reducing or if possible eliminating the discrepancy between the overall workforce and STEM workforce percentages represents the fundamental mission of TWIST. Focusing

[1] National Science Foundation. *Women, Minorities, and Persons with Disabilities in Science and Engineering: 1998*. Arlington, VA, 1999. (NSF 99-338)

now on Chapter 3 of the NSF report, which quantifies production of undergraduate (UG) STEM degrees, we note the following data:

	All UG Degrees (1966)	STEM (1966)	All UG (1995)	STEM (1995)
Women	42.6%	24.8%	54.8%	46.5%
Men	57.4%	75.2%	45.2%	53.5%

Table 2. Production of UG STEM degrees.

These percentages clearly show that women have made excellent progress in obtaining UG degrees in all fields, overtaking the production of men by 1982. Women have likewise made very good progress in obtaining STEM degrees. The percentage of Engineering degrees earned by women showed the steepest increase, from 0.4% in 1966 to 17.3% in 1996. Despite this sharp increase, Engineering remains the most male-dominated of all STEM fields. Psychology is the most female-dominated of all STEM fields, with 40.8% women in 1966 and 73.0% women in 1995. By 1995, women still earned a minority of UG degrees in the other STEM majors, in the range of 30–50% depending on the field.

Chapter 5 of the NSF report focuses on the demographics of the STEM workforce. These statistics count where people work, irrespective of their previous training. For example, if a person received a biology degree but works in a chemistry-related field, they are counted in the chemistry workforce. I focus here on chemistry statistics, although analysis of other fields might be as or more interesting. In 1995, women earned 43% of all chemistry bachelors degrees and constituted 29% of the bachelors chemistry workforce. A portion of this decrease might be attributable to women entering graduate school, although this is not certain. In 1995, women earned 30% of all chemistry doctorates, and constituted 15% of the doctoral chemistry workforce. This decrease is curious and potentially troublesome, and should certainly be the subject of future research.

UMass OIR Report: The UMass OIR report indicates the following composition of students entering UMass with their major already declared:

	UMass All	Other All	UMass STEM	Other STEM
Women	50.9%	50.3%	38%	36%
Men	49.1%	49.7%	62%	64%

Table 3. Gender composition of UMass and peers.

These data clearly indicate that UMass is typical of the institutions considered in the Oklahoma study, and that many more men than women enter UMass with STEM majors declared. The OIR report, which contains a large amount of data, can be accessed at (http://www.umass.edu/twist/oirrep.html). Here we summarize the most salient points, by focusing on the following quantities for students entering UMass in 1993:

- Continuation rates to second year,
- Continuation rates to third year,
- Graduation rates in four years,

- Graduation rates in six years.

The OIR report contains such information for only two years: 1992 and 1993. The trends are identical between these two years; as such we only show data for 1993. We show these data for women, men and all students for the three groups of students discussed above.

	Cont 2nd Year	Cont 3rd Year	Grad 4th Year	Grad 6th Year
Total	77.4%	66.8%	38.0%	60.0%
Women	80.3%	68.0%	45.7%	64.8%
Men	74.5%	65.7%	30.4%	55.3%

Table 4. Overall retention/graduation rates in 1993.

	Cont 2nd Year	Cont 3rd Year	Grad 4th Year	Grad 6th Year
Total	77.0%	68.2%	31.9 %	61.1%
Women	80.3%	69.7%	41.9%	66.6%
Men	75.0%	67.3%	26.0%	57.8%

Table 5. Retention/graduation rates for 1993 first-years starting in SMET.

	Cont 2nd Year	Cont 3rd Year	Grad 4th Year	Grad 6th Year
Total	51.2%	43.1%	21.7%	38.8%
Women	52.8%	43.3%	28.4%	42.7%
Men	50.3%	43.0%	17.7%	36.4%

Table 6. Retention/graduation rates for 1993 first-years starting and ending in SMET.

The retention/graduation rates are very similar between Tables 4 and 5, but are quite different in Table 6. In all cases, though, women are outperforming men in terms of retention and graduation, even those women who begin and graduate with STEM degrees. In particular, 356 women (37.5%) and 593 men began at UMass in 1993 with STEM majors. After six years, the women cohorts earned 152 SMET degrees (41.3%) while the men earned 216 SMET degrees. Thus, our preliminary conclusion is that, overall at UMass, *attrition of women from STEM majors does not contribute to the paucity of women in STEM careers*.

Chemistry Report: Although the OIR data looks promising for women in STEM majors, data from individual departments and/or courses may reveal different stories. To pursue this, we study UMass Chemistry Department data, which show the percentages of women and men who earn grades in Chemistry 111 and Chemistry 112 that are sufficient to allow preregistration in the next Chemistry courses, namely Chemistry 112 and Chemistry 261/265 (Organic Chemistry), respectively. We also show the percentages of women and men students who move on from Chemistry 111 to Chemistry 112. All these data are shown for the following three academic years: Fall 1997–Spring 1998, Fall 1998–Spring 1999, and Fall 1999–Spring 2000.

	Fall 97	Fall 98	Fall 99
Women	77.7%	77.5%	80.0%
Men	73.8%	76.3%	76.5%

Table 7. Percentages earning a CD or higher in Chemistry 111.

	Spring 98	Spring 99	Spring 00
Women	70.6%	65.6%	66.8%
Men	77.9%	56.9%	48.6%

Table 8. Percentages continuing to Chemistry 112 from Chemistry 111.

	Spring 98	Spring 99	Spring 00
Women	86.9%	82.0%	87.7%
Men	85.9%	76.3%	86.0%

Table 9. Percentages earning a CD or higher in Chemistry 112.

Tables 7 and 9 show that women consistently outperform men in terms of the likelihood of earning a CD or higher in the introductory chemistry classes, Chemistry 111 and 112. Table 8 shows that women generally have a higher likelihood than men of continuing on into Chemistry 112, although that is not generally an indicator of success considering that many majors only require one semester of chemistry. Nonetheless, the data in Tables 7–9 show trends that are broadly consistent with the OIR report, namely, that women thrive in early Chemistry courses relative to men.

Impact. We began by asking if women are leaving STEM majors at disproportionately large rates. In general, we have found that *the retention and graduation rates of women in STEM majors are superior to those of men.* This finding holds here at UMass, and at comparable institutions as well.

Despite these larger retention and graduation rates for women, the percentages of women graduating with STEM degrees are still not close to the percentages of women graduating from college overall, which is *ca*. 54%. This study suggests that new academic policies for approaching gender equity in numbers of STEM graduates *should not focus on college retention issues*, but rather on increasing the number of women entering college with interests in STEM fields. Such changes will likely take place at the *middle school* and/or *high school* levels.[2]

Future Research. We plan future research in two areas:

- Analysis of undergraduate retention/graduation rates from individual departments,
- Analysis of graduate retention/graduation rates from individual departments.

Although the OIR data looks promising for women in STEM majors, data from *individual departments* may reveal different stories; the Chemistry data shown above is just a start. We plan to track the numbers of women and men majors in several STEM departments over time, i.e., longitudinal analysis of departmental cohorts, in

[2] P. Orenstein, "*School Girls*," Anchor Doubleday, New York, 1994.

collaboration with OIR. Such analysis will reveal if particular departments are either very good or very bad in terms of retention/graduation rates of women relative to those of men. We also plan to repeat the analysis shown above for *graduate students*, overall at UMass and in individual departments, to determine if attrition from the graduate ranks contributes significantly to the scarcity of women in STEM careers.

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