

The Role of Hands-On Female Student Project Teams in Comprehensive Outreach and Retention Programs

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Abstract - Based on recent statistics by the US Department of Labor, only eleven percent of Aerospace Engineers and only 5.6% of Mechanical Engineers are women¹. Considering that 47% of the general US workforce is comprised of women, continued and increased efforts are needed to increase the number of women entering the engineering workforce. Like many institutions, Embry Riddle has struggled to attract women to our engineering programs. The university is working to increase female participation in all aspects of the engineering program. As shown in figure 1, a component of the comprehensive EmpoWER (Empowering Women at Embry Riddle) program to attract and retain young girls to the engineering field is to provide role female models to dispel the perception that engineering is a male dominated field.

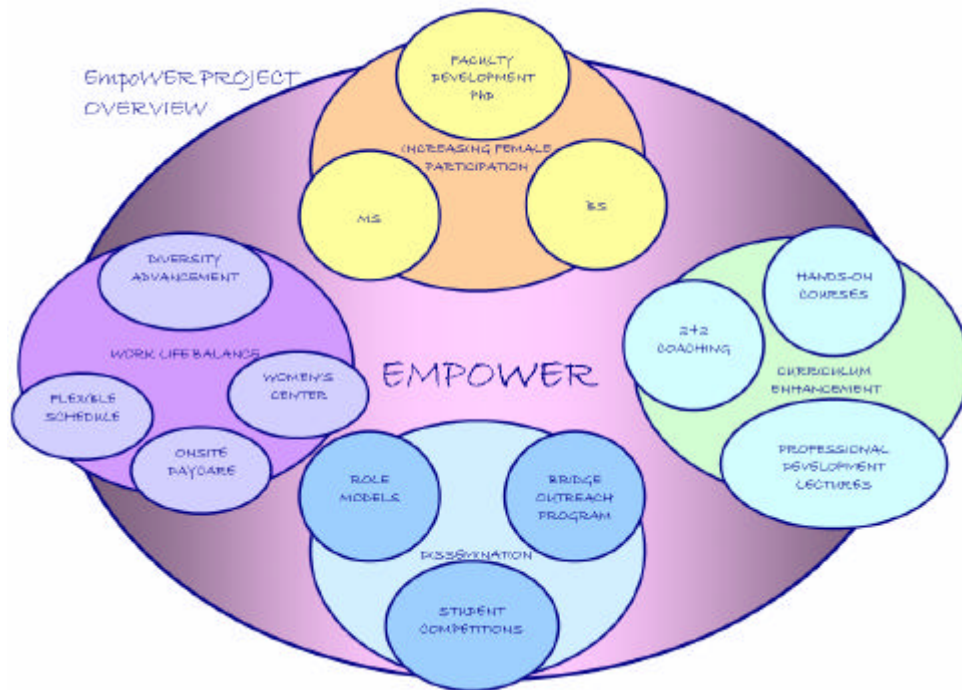


Figure 1: Components of EmpoWER Program

The EmpoWER programs has the objective of increasing the number of women at all level in the engineering program, including undergraduate students, graduate students and faculty. To assist in attracting and retaining female undergraduate students, a hands-on all-female student design project was used to provide role models, disseminate information about women in engineering and education young girls about engineering. The basis for this project was the Baja SAE competition, which is a popular student design competition organized by SAE International. Female involvement in the design project has skyrocketed since the all-female team was established. In 2005-2006, roughly 20 women participated in the first year of the all-female project, an increase of 1000 percent. In 2006-2007, almost 80 women signed up for the project.

Introduction

The lack of women in engineering is not a new problem and is easily solved. Institutions, such as Embry Riddle, that focus on degree programs that are historically dominantly male have wide demographic difference. As shown in figure 2, the U.S. workforce is almost evenly split between male and female employees, in general. In an ideal world, the percentage of women in the engineering workforce and engineering programs would mirror the national workforce statistics.

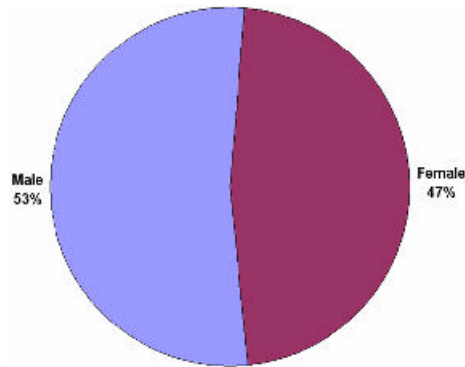


Figure 2: Percent of Women in U.S. Workforce

The statistics for Aerospace Engineering and Mechanical Engineering, which are the two largest engineering programs at Embry Riddle, indicate a significant divide between male and female employment in the national workforce, as shown in figure 3.

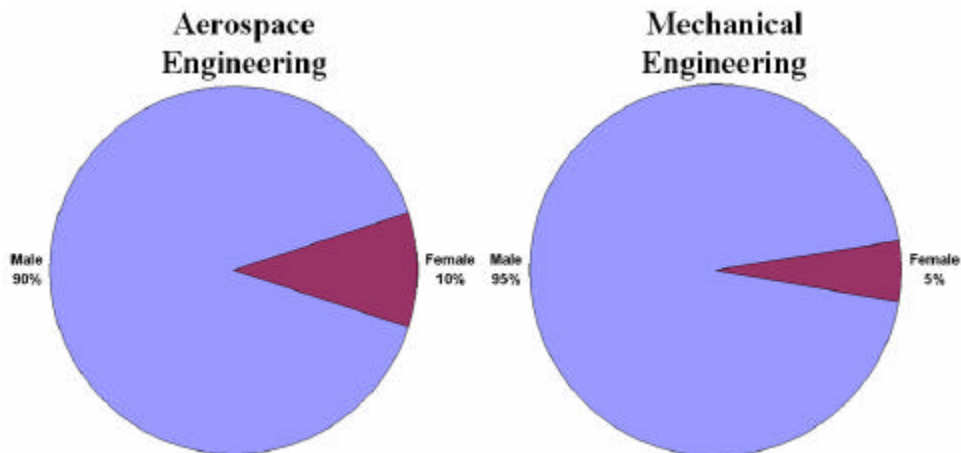


Figure 3: Percent of Women in U.S. Engineering Workforce

As shown by figure 4, Embry Riddle has a large engineering population and subsequently low overall female population. As a private institution, only degree programs that fit within the mission of the university are offered. Some degree programs, such as communications, that have traditionally appealed to female students are not offered. So, there are limit opportunities for female transfer students from other degree programs. The engineering programs must attract women directly through dissemination and outreach programs.

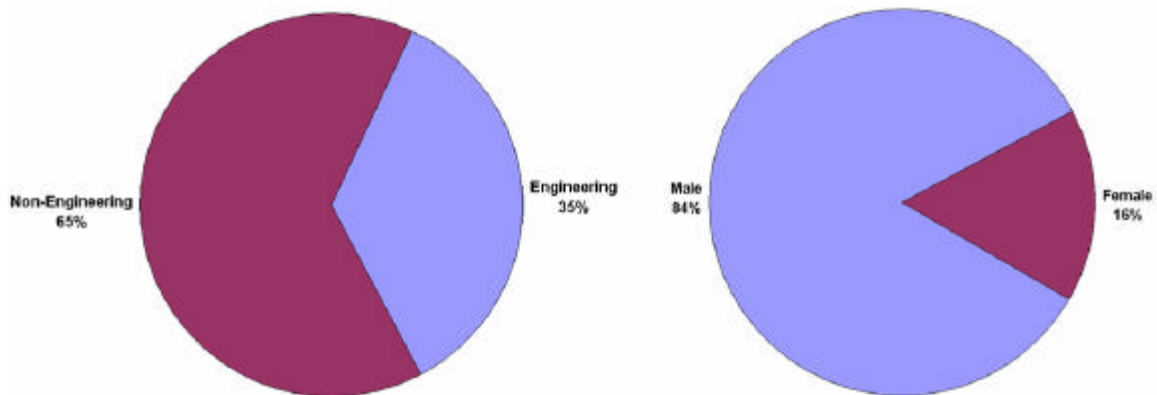


Figure 4: Percent of Women Students and Engineering Students at Embry Riddle

The Embry Riddle engineering programs have struggled to attract female students. As shown in figure 5, the total percentage of women in the college of engineering is about 14 percent. While these numbers aren't unusual for engineering programs, they are below what should be considered acceptable.

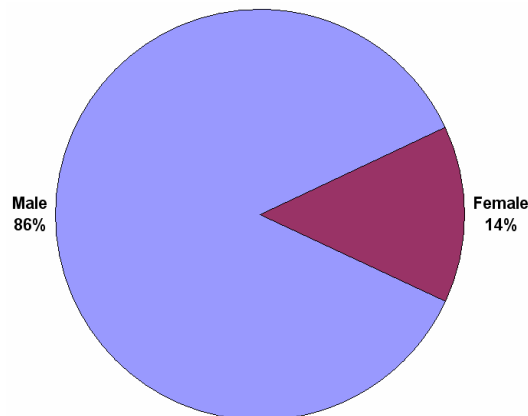


Figure 5: Percent of Female Engineering Students at Embry Riddle

After researching the issue, it was decided that improving the number of female engineering students required a broad effort. This effort is defined as the EmpoWER program (Empowering Women at Embry Riddle).

EmpoWER Program Background--The EmpoWER Program is designed to increase interest and participation of women at all academic levels (from middle school through graduate school and beyond). The program includes initiatives to increase the number of female students and faculty. There are four categories to the program; curriculum enhancement, dissemination, increasing female participation through scholarships, and work-life balance.

Having a relatively high percentage of female faculty is an important factor in recruiting and retraining female engineering students. Studies have shown that women are more likely to accept a position at a family friendly workplace. Work-life balance is an important issue for attracting and retaining women faculty. The university has recently opened a women's center and day care. The program also ensures that a female faculty member is on every faculty search committee, even if they are not from the same department as the opening.

Increasing female student and faculty participating in all levels of research is another element of the proposal. This is accomplished by pursuing research and funding important to female students, such as increasing enrollment of women in engineering. The additional research and educational funding will be used to fund graduate and undergraduate students. Non-tenure track female faculty members are

encouraged to pursue research that will enable them to attain doctorates and perhaps switch to tenure track position, when available.

Providing support for female engineering students in and out of the class room is another element of the EmpoWER program. The curriculum will be enhanced through a mentoring program, a professional development course for women in engineering, and hands-on female design projects.

Another goal of the EmpoWER program is the development of an effective engineering outreach program. For any program to be successful in attracting and recruiting more women into engineering, it must have a successful outreach program. The university provided funding to implement an outreach program on a trial basis, which has shown very positive results. To have a significant impact, the scale of the outreach program needs to be expanded. The EmpoWER program includes funds to extend the outreach program to include educational conferences, exhibition at local elementary, middle and high schools, community colleges and other universities, development of an interactive website and development of an educational DVD.

One of the key elements of the program, especially for dissemination and curriculum enhancement, is the Women's Baja SAE team. The project is an integral part of the EmpoWER program and provides role models for first year students, empowers women to become more involved in engineering, creates a demonstration tool to education young girls about the engineering discipline, and provides an outlet for dissemination through student competitions and exhibitions.

Baja SAE Project Background--The Society of Automotive Engineers (SAE) International sponsors a series of engineering competitions called the Baja SAE series, formally called SAE Mini-Baja. The Baja SAE project requires student teams to design, analyze, fabricate, test and compete a single seat, all-terrain vehicle that must endure a rigorous obstacle course including 3-4 foot drops, railroad ties, logs, thick mud-bogs, and rocks. The Baja SAE competition consists of over 100 teams world-wide competing their student-designed and fabricated baja vehicles in several static events (including design, safety inspection and 4-wheel lock-up braking demonstration) and dynamic events (including a log pull, acceleration demonstration, land and water maneuverability, and traction and suspension demonstration, and mud bog traverse) and closing with a 5 hour endurance race. The East competition also requires the vehicle to be amphibious.

The project is organized as part of a club, ERAU Mini-Baja Club and students may work on the project as an extra-curricular activity or as a special topics project. The club is closely affiliated with two professional chapters on campus; the ERAU SAE chapter and ERAU Society of Women Engineers (SWE) chapter. Membership in the SAE chapter is required by the rules of the competition.

Baja SAE Team--The number of women participating in the project has grown significant since the all-female team was introduced in 2005-2006, as shown in figure 6. The number of women participating in the co-ed team has remained small during that time. The only female student participating on the 2006-2007 co-ed Baja SAE team was one of only two women to participate on the 2004-2005 co-ed team. So the total number of female students to participating on the co-ed team was only two students. The results achieved by the all-women's baja team are even more impressive when compared to the co-ed team.

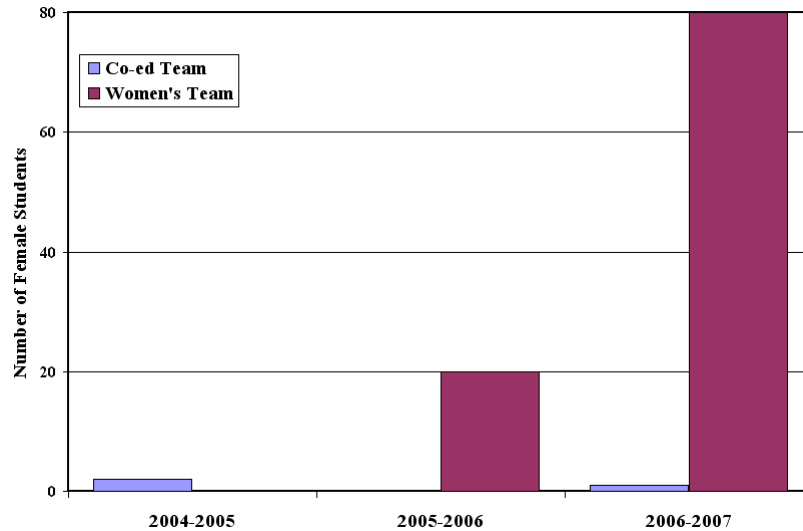


Figure 6: Number of Female Students on Baja SAE Teams

Team Organization--The ERAU Baja SAE Club consists of both a co-ed team and an all women's team. The all women's team is only one of three all women collegiate Baja SAE teams in the U.S., and is the only one in the world with female advisors. 2005-2006 was the first year that ERAU had an all women team, and was the first year any of the women's team members had ever participated in the project. The team performed phenomenally for a first year team, placing in the top 30 in each of the dynamic events, and placed 44th overall (static, dynamic and race combined) out of the 65 teams which were able to compete their vehicles.

Relationship to EmpoWER Objectives--The Women's Baja team has been a huge success in creating an opportunity for women engineering students to learn, flourish and succeed without help or interference from male students. This gives the students a feeling of independence and confidence that is much needed when working in a field dominated by a single gender. This opportunity enhances the academic environment for the women engineering students thus increasing the likelihood of their retention in engineering and success in their field². Figure 7 shows some of the 2005-2006 women's Baja SAE team at the 2006 Baja SAE competition hosted by Auburn University. The project combined with the competition, created a unique bonding experience for many of the women on the team.



Figure 7: Women's Team at 2006 Baja SAE Competition

The outreach program is designed to inspire young girls to join engineering disciplines. Exhibits at regional elementary, middle, and high schools are being used to introduce young girls to engineering and provide role models for them. The exhibit includes interactive displays, a presentation on engineering as a career, a description of the Women's Baja SAE project, and descriptions how engineers impact the world as a whole. During the presentations, the entire design cycle of the ERAU's Baja SAE team's vehicle, from paper design to fabrication and finally the demonstration of the vehicle at the Baja SAE competitions is described and illustrated. At the end of the presentation, attending students are given the chance to ask questions and each of the team members are given the chance to provide comments on their experiences on the Baja team and as an engineering student. Finally, the presentation is concluded by allowing the students to see the actual competition vehicle, sit in it, and watch a demonstration of it driving. The excitement of seeing an all-terrain vehicle designed and built by students is demonstrated by the students' reactions. Figure 8 shows the women's Baja SAE team at an outreach exhibition at Sculptor Charter School.



Figure 8: Women's Baja SAE Exhibit at Sculptor Charter School

Team Survey--The surveys used to assess the Women's Baja Project were given as statements to which the participants respond with either "Strongly Agree", "Agree", "Neutral", "Disagree", or "Strongly Disagree". The questions are designed to determine if the women's Baja SAE experience is a new experience not duplicated through class projects. As shown in figure 9, most of the team felt that they were not exposed to many predominately female or equally proportionate design teams in the normal curriculum. 100% of the women felt that design teams in classes were predominately male, of which, 73% strongly agreed with this statement.

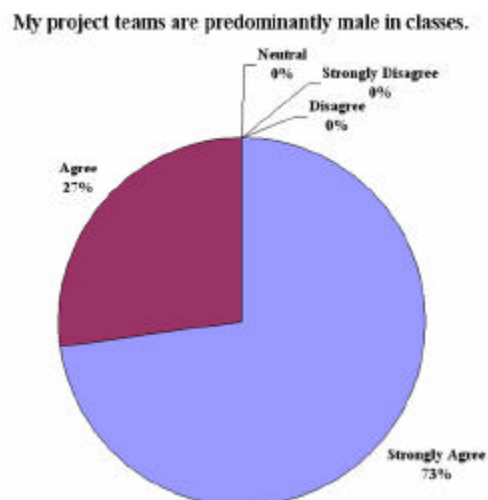


Figure 9: Survey Results (Predominately Male Project Teams)

As shown by figure 10, most of the women on the Baja SAE team felt that the women's Baja SAE project created a new opportunity for them to bond with other female engineering students that would not exist otherwise. While there are other women engineering groups on campus, such as SWE and Women in Aviation, the women's Baja SAE team is the female group with a hands-on design project. 85% of the team agreed with this statement, with just over half of the respondents strongly agreeing.

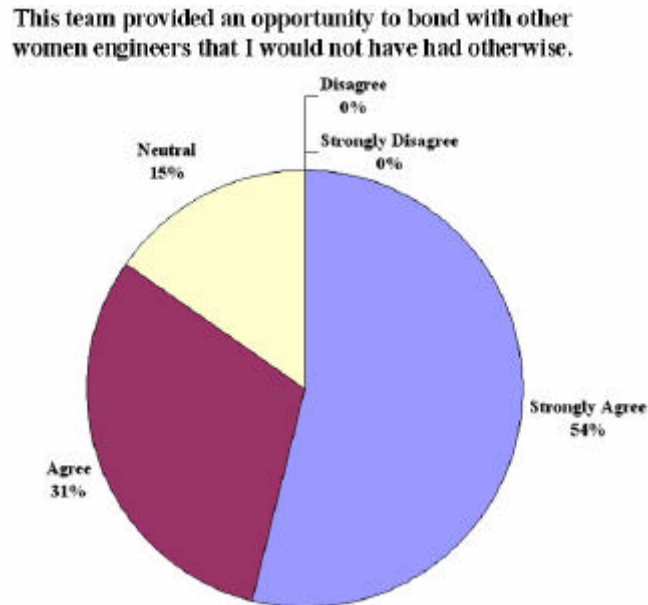


Figure 10: Survey Results (New Bonding Opportunity)

In most cases, being on a team with other women gave the team members more confidence. 85% of the team member believe they were more willing to try new things because the team was all-female, with over 30% agreeing strongly.

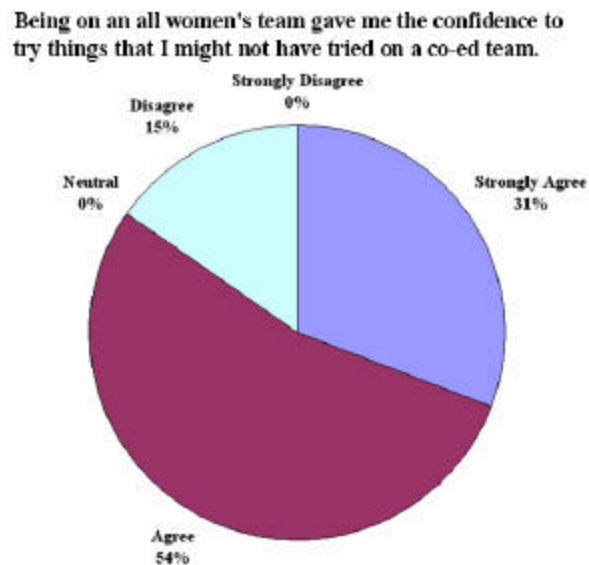


Figure 11: Survey Results (Confidence)

When asked if the women's baja team would help them in their field of study, the team overwhelmingly agreed. 92% felt that they would do better in their degree program as a result of the women's baja project, with 46% strongly agreeing.

Being a part of this team is important to my success in the engineering program.

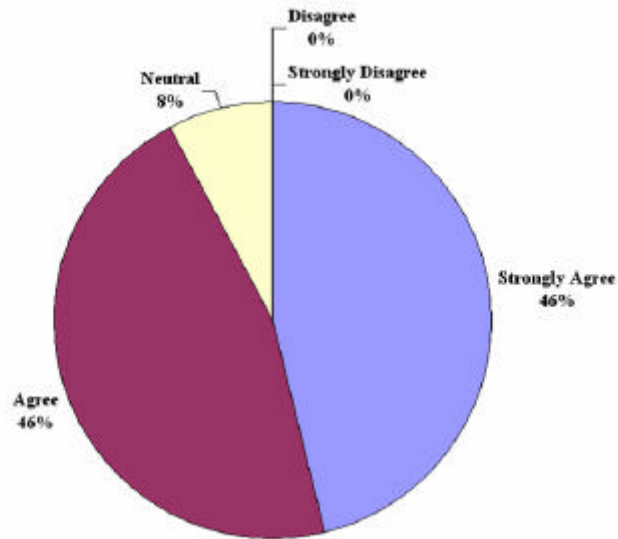


Figure 12: Survey Results (Success in Engineering)

These results were less obvious when asked about a connection between the baja project and individual classes. The results were evenly split between positive and negative responses. Some women indicated that the project took time that they could be studying. 69% of women felt that the project improve their understanding of engineering, in general. This highlights the need to show how the project relates to specific common engineering courses, such as statics, dynamics, etc.

Being a part of this team is important to my success in my engineering classes.

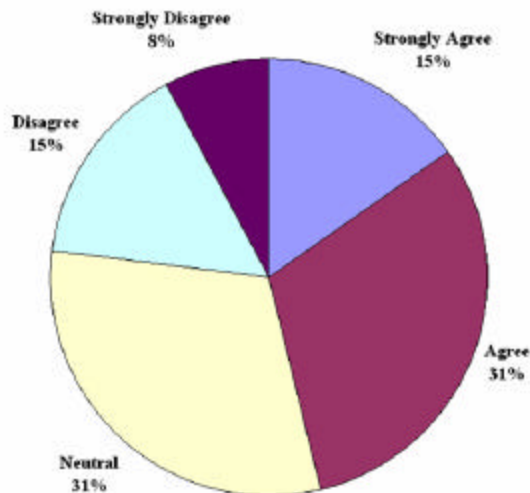


Figure 12: Survey Results (Success in Classes)

One issue with relating the project more closely with specific engineering courses is the team demographics. Many of the team members are freshmen that are not taking specific engineering courses. Since the project is intended to include women from all academic levels, the manner that individual courses are included needs to be carefully considered.

Project Facilities and Budget--While the project shows great benefits, it does take significant resources. The vehicles are design in existing computer labs with readily available software. The design and construction of the vehicles require access to a student machine shop and an assembly area. Embry Riddle recently invested over \$200,000 upgrading the student machine shop to include a four-axis CNC mill, CNC lathe, laser cutter and TIG welder. The demand on faculty time is also significant. Two faculty advisors oversee the women's team and another faculty advisor currently advises the co-ed team. The annual budget for the women's baja SAE team is summarized below.

Tooling	\$2500
Vehicle	\$5000
Travel	\$5000 per competition
Travel	<u>\$1000 outreach</u>
Total	\$13,500

Based on survey results, 92% of participants feel that this opportunity is important to their success in the engineering program. 85% of participants felt that an all women's team gave them the confidence to try things they wouldn't otherwise try if they were on a co-ed team. 100% of participants agreed that this opportunity is important for women to have. Finally, 100% of students not graduating this year plan to participate in the project and remaining in engineering again next year.

The all-women Baja SAE project is a unique experience that adds value to women engineering students' academic experience. The project creates role models for incoming freshmen and young girls at middle and high schools that may choose engineering. The project also creates a demonstration tool that allows students to quickly confer to prospective engineering students what engineering is about and that engineering isn't a male only field. The project is an important component of a broad approach to increasing diversity and the dramatic increase in female participation in the Baja SAE project indicates that the project is working.

References

¹ US Department of Labor website, <http://www.dol.gov/wb/factsheets/nontra2003.pdf>, last updated: March 2003.

² Ginoria, Angela. Warming the Climate for Women in Academic Science. American Association for Colleges and Universities, 1995