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Areas of Research: Equity issues in science and engineering, teacher professional development

# Instructional Interventions that Foster Women's Interest, Retention, and Success in Undergraduate Engineering

## Learning From the Research



# The Problem

Recruitment

Retention

# Recruitment

## Percentage of Undergraduate Degrees Earned by Women

Field	Percentage
Biology	60
Chemistry	50
Agricultural Sciences	50
Earth, Atmospheric and Oceanic Sciences	41
Physics	21
Computer science	19
Engineering	19/17 (Canada)

# In their own words

“I probably want to work with the earth, the earth and like help people. Work where it can save the earth and not die.”

“I plan to study zoology, animal behavior. I want to work with animals. I want to protect animals. I’m very against animal cruelty, stuff like that. I want to help extinct animals, I want to work with them, I want to help. I want to work with people explaining, you know, why not to kill elephants for their tusks.”

“Scientist scientist is like the scientists that work at NASA with chemicals and stuff, so you know they work with the periodic table. I wouldn’t want to be a scientist scientist, you could create bombs. Bombs create wars you know.”

“I built this rocket because my dad built rockets when he was little. I named it puppy because of the puppy and nature stickers I put on the nose cone and then I added a big number. I’m pretty much interested in animals but I think I will be a rocket launcher too when I grow up.” 10 year old Aly Houle talking about her rocket she named Puppy Nature 10,000.

“An astronomer, cause I like stars, you know it’s neat. My gradpa he used to take me, well he still does a little bit. He takes me out on his wooden deck cause he lives by the beach, you know, the cliffs and he takes me out in the middle of the night. Dresses me up in sweaters and he’ll go oh look there’s Mars. I really like that so that’s probably why I like it (astronomy).”

# Changes in Earned BS Degrees From 1993-2007 USA

1993		2007
Males 52,724	➡	55,621
Females 9,981	➡	12,653

Male increase = 2,897  
Female increase = 2,672



# Changes in Earned BS Degrees from 2001-2009 Canada

2001

12%

2009

17%

40% in bioengineering

39% environmental engineering

# The Numbers USA

Field 2007	Males	Females
All	55,621	12,653
Aerospace	2,376	542
Chemical	3,338	1,743
Civil	8,819	2,499
Electrical	16,438	2,109
Industrial	2,473	1,056
Materials	753	272
Mechanical	14,894	2,017
Other	6,530	2,505

# Retention and In-Migration

Persistence rates vary by institution 38-57 %

Male/female persistence rates are the same

Males and females leave for the same reasons

Female leavers have the same grades, work as hard as male stayers

Female leavers do not have a stronger vocation elsewhere

No in-migration from other majors because females see it as a “boys club”

# The Challenge

Changing the Perceptions

Changing the Culture

Changing the Curriculum

Changing the Pedagogy

# Negative Perceptions: Why Women Leave

Engineering careers perceived as

- Unfulfilling
- Lacking balance for family life and children
- Lacking balance for social life
- Not serving altruistic goals
- Not making social contributions

# Negative Educational Experiences: Why Women Leave

- Culture, Curriculum and Pedagogy results in
  - Lower self-efficacy
  - Feelings of isolation and not belonging
  - Weak engineering identity

Dr. Aboulnasr, Dean of Applied Science &  
Professor of Electrical Engineering, University of  
British Columbia

“Collectively, we have focused too much on the technology side, on building things. Women tend to want to help people and choose careers that allow them to make a meaningful contribution to society, and may not see how engineering can have such an impact. Somehow we lost the message that engineering can improve people’s lives.”

# What women Say They Dislike About the Culture

- Lack of community
- Weed-out courses
- Predominantly male faculty
- Masculine metaphors and examples
- Engineering identity as male
- Impersonal faculty student relations
- Tough it out ethos
- Aggressive male speech patterns during team work
- Females perceived as incapable, whiny, insecure and time wasting when using female speech patterns during team work
- Lack of mentors



# What Women Say They Dislike About the Curriculum

- Large intro courses
  - Alienating, lacking depth, excitement, individual attention
  - No connection between course content and engineering and real world
  - Poor organization of syllabus
  - Few opportunities to do real engineering (27% design projects in first year)

# What women Say They Dislike About Engineering Pedagogy

- Teacher-centered lectures (65%)
- Passive learning
- Competition as a motivator
- Women's work in teams not publicly acknowledged
- Insufficient feedback
- Insufficient reinforcement
- Comparisons with classmates
- Doesn't build on women's strengths

# Solutions

- Research
  - Engineering education
  - Cognitive science
  - Science education
  - Psychology
  - Sociology

# The Solutions - Perceptions

- Successful role models who balance career, family, social life
- Engineering service learning activities
- Early business internships
- Design projects for third world needs
- Support courses – Case studies of how engineers contribute, history of inventions

# The Solutions - Culture

- Living & learning communities or women engineers floor
- More personal/social relations with faculty
- More women faculty and TAs
- More women faculty in leadership positions
- Women faculty recruiting and advising students
- Family like department climate
- Strong social networks (vertical & horizontal)
- Peer mentoring, cross cohort mentoring & formal mentoring
- Zero tolerance for disrespectful or uncollegial behavior towards women
- Atmosphere where being wrong is OK
- Tracking system for at-risk students & intervention program

# Solutions – Curriculum

- Earlier engineering & design experiences to build skills and interest
- More connections to the real world & engineering in intro science and math courses
- Include the back story – how engineering methods were developed, why physics and chemistry understand the world in particular ways
- Neutral examples and metaphors
- Earlier and more examples of how engineering helps individuals, the environment, and society
- Manageable workload
- Bridge programs
- Pre-college orientation

# Solutions- Pedagogy

- Interactive teaching
- Student centered teaching
- More individual attention
- Smaller classes
- Openness to requests for help
- More collaborative activities
- More time to complete tasks
- Fewer competitive activities
- More detailed and more frequent feedback
- Public recognition of women's contribution to team activities
- Choose women for leadership activities
- Build self-efficacy with persuasive messages and vicarious experiences
- Teach collaboration and teamwork
- Teach effective communication patterns

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# Discussion Questions

What Can We do at ASU to change perceptions of engineering?

What can we do at ASU to change the engineering culture?

What can we do at ASU to change the engineering curriculum?

What can we do at ASU to change pedagogy?