

The Importance of Research Experiences to Attract Girls to Science and Engineering

***Workshop on Women in Science and Engineering
Jefferson Lab***

Newport News, VA

16 November 2009

Beverly K. Hartline

University of the District of Columbia

Women in Physics: Few but Fantastic!



Marie Curie

C.S. Wu

Lise Meitner

Maria Goeppert Mayer

And others

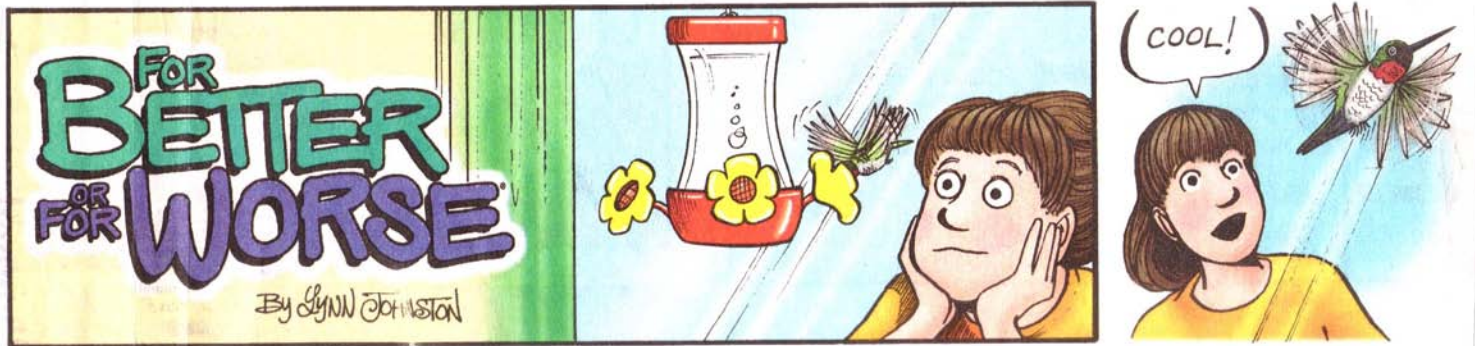
- How many girls and women had **potential** to be great scientists, but **no opportunity**?
- What **ideas were lost** to science & science education because few women participated?
- How many **children** have poor science literacy, because their mothers knew no science?

Science and Engineering Need Minorities and Women



- **Science and engineering are about...**
 - Questions
 - Ideas
 - Extrapolation and prediction
 - Systematic observation
 - Communication
 - Interpretation, deduction, and understanding
- **Women & minorities strengthen
and enrich the enterprise
! But they are too scarce in most fields**

"Mom, Have You Ever Wondered How A Bird's Wings Could Beat so Fast?"



Third International Conference

- **Seoul, Korea October 2008**
- **Organized by IUPAP Working Group on Women in Physics**
- **Thanks to support from NSF, ~30 US universities and DOE National Laboratories, and international sponsors**



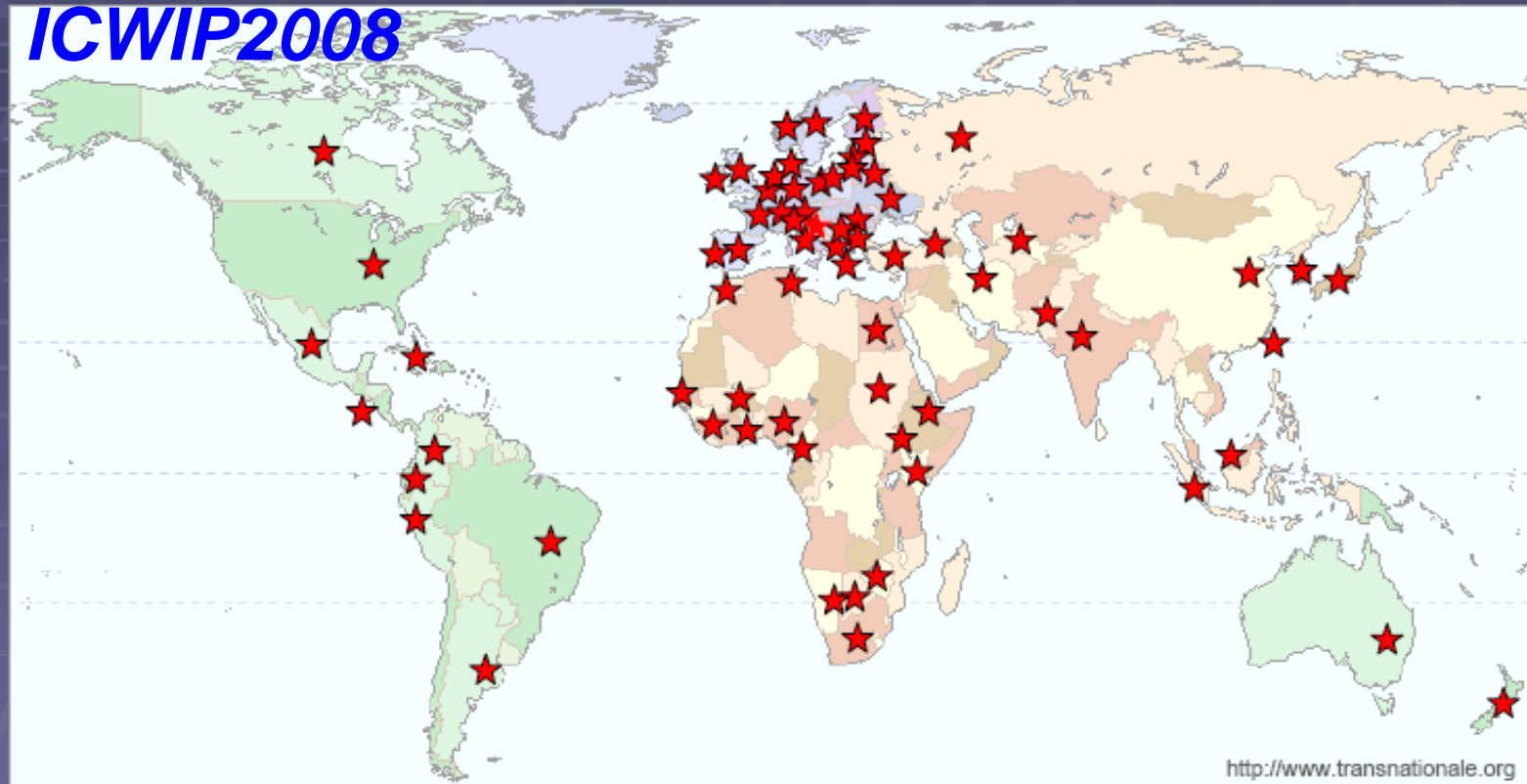


UNIVERSITY OF
THE DISTRICT
OF COLUMBIA



~300 from 57 Countries; 15% men

ICWIP2008



- academic institutions
- national laboratories
- industry

- scientific societies
- national governments
- granting agencies

From Y. Zastavker

ICWIP 2008 Unanimous Resolution



1. Promote through IUPAP Liaison Committees and physical societies the formation of **regional or national working groups** for women in physics.
2. Publicize **site visits** as an effective tool for improving the "climate" of physics workplaces & encourage their implementation.
3. Actively encourage IUPAP conference organizers to provide (a) **professional development** workshops for attendees, and (b) **outreach** aimed at the public & to excite both girls and boys about physics from an early age.
4. Charge the Working Group on Women in Physics to (a) oversee administration of a **global survey** of physicists, (b) continue to assess progress, (c) make useful resources available globally through the internet, (d) organize **4th conference in 2011**, & (e) report at 27th General Assembly.
5. Urge Liaison Committees and physical societies to encourage **broad participation in the global survey** in their countries.

Bringing Up Girls & Boys

- **Get dirty**
- **Take things apart and put them together (or maybe not)**
- **Work with tools**
- **Explore and build**
- **Do sports and outdoor games**
- **In team projects, be the leader and innovator**
- **Be energetic & rambunctious**
- **Think for himself**
- **Stay clean**
- **Keep things whole, neat and pristine**
- **Use paintbrushes artistically**
- **Read and write**
- **Play quietly indoors**
- **In team projects: be a follower and note-taker**
- **Cook following recipes**
- **Don't question**

Preparation for interest and success in science and engineering?

Attracting Girls and Minorities to S&E



- **Parents who love science and math and encourage curiosity**
- **Precollege math & science with great teachers**
- **Contact with real scientists & engineers**
- **Opportunity to do research: experience the challenge of inquiry and joy of discovery**
- **Introductory college courses that intrigue, challenge, and invite**

Issues Affecting Access and Success



- **Childhood**
 - Gender schema & accumulation of disadvantage
 - Role models and popular stars/heroines
 - Encouraged activities and experiences: RESEARCH
 - Peer pressure — especially the expectations of boys
- **Education and Early Career**
 - Gender schema & accumulation of disadvantage
 - Loneliness and isolation
 - Role models and supportive mentors
 - Special opportunities to lead and excel
- The ***INCREDIBLE*** challenges and barriers faced by girls and women of color

Other Issues



- **Self confidence—the courage to tackle the unknown or start a complex project that you've never done before**
- **Practice thinking like a scientist: questioning, exploring, discovering, verifying**
- **Guidance counselors, teachers, neighbors, parents — the significant adults in every girl's life**
- **Peer pressure, especially from boys and men**
 - We will never achieve sustainable improvements for women without changing the expectations males of all ages have for the females in their lives

School Teachers are Key



- **May be the first science people children meet**
- **Often they are female role models**
- **They share their love (or fear) for science and math**
 - Engage students with hands-on, inquiry-based pedagogy
 - Nurture and reward students' curiosity
 - Encourage/tolerate "getting dirty"
- ➔ **Universities MUST prepare teachers able to invite, engage, and inspire children about science and math**
- ➔ **Especially important for children with no role models or encouragement in their families/communities**

Hands-On Exploration Aids Discovery



Questions Help Girls Think Like Scientists



- How?
- Why?
- What if?
- How can we find out?
- **Encourage her to ask questions & discover answers**
 - Stimulate her to explore and experiment
 - Help her invent many ways to find out
 - Have her discover that many questions have more than one answer
 - Let her evaluate the answers
 - ***THIS IS RESEARCH***

How Can We Build the Fastest Solar Car?



Questions that Encourage Scientific Thinking



- **What is similar/different about . . . ?**
- **Describe the interactions between . . . ?**
- **What do you think makes that happen?**
- **What would happen if?**
- **What might change if it were hotter? Colder? Faster? Slower? Lighter? Darker? . . .**
- **What factors do you think might be important?**
- **How could we find out?**

– **From my mother**

Involve Girls in Research Early



- Most children have never met a scientist and don't know how exciting science is
- Most girls have no encouragement to do science
- **Doing research** in secondary school or early undergraduate years encourages curiosity and infects students with a passion for discovery
- MacArthur prizewinner, Deborah Jin (JILA/NIST), says **summer research at NASA after her sophomore year in college** “pretty much settled things. I knew from that point on that I was going to be a physicist.”

What is Student Research?



- **An inquiry or investigation**
- **Conducted by a student or team of students**
- **Often in collaboration with a teacher, parent, or mentor**
- **That makes an original or creative “discovery”**
- **Usually without following a recipe to achieve a known answer**

Documented Gains from Early Research



- **Advancing cognitive and intellectual growth**
 - Knowledge and skills
 - Academic achievement and educational attainment
- **Fostering professional growth and advancement**
- **Promoting personal growth**
 - Curiosity and confidence
 - Independence & initiative
 - Recognition and respect
- **Especially important for children who have not been guided or encouraged to think like scientists**

- From Osborn & Karukstis in *Broadening Participation in Undergraduate Research*, 2009

Discovery through Research



Doing Research

Sharing the Results



Understanding the Challenges

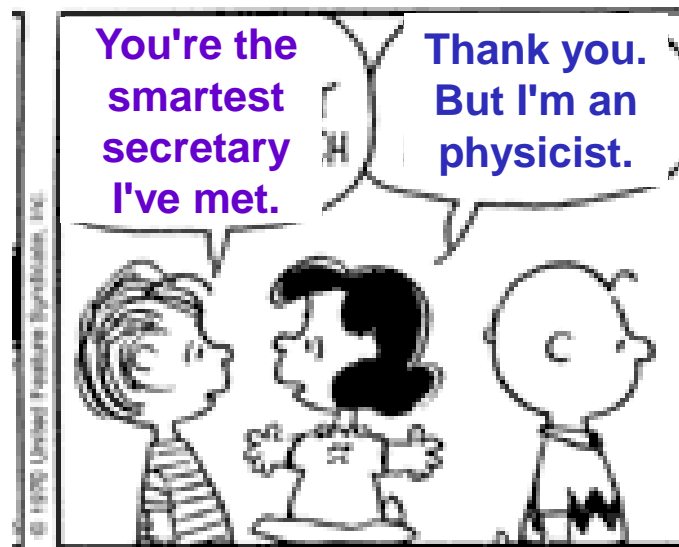


- According to Dr. Virginia Valian (author of *Why So Slow?*) two key concepts help explain the difficulties girls and women face entering and advancing in science and engineering
 - ❖ “Gender schema”
 - ❖ Accumulation of advantage
- These hidden challenges are likely to be aggravated for under-represented minorities

Gender "Schema"

- Gender and ethnic "schema" are widely held beliefs about men, women, and people from ethnic groups with respect to their competence, career roles, and leadership ability
 - Lead us to overrate white men
 - Lead us to underrate women and minorities

***Overheard
at the Physics
conference:***



Drawing © UFS, Inc, 3/6/04

Accumulation of Advantage



- **"Accumulation of advantage" refers to the cumulative long-term effect of small differences in the way males and females from different ethnic groups are treated throughout their lives**
 - At home and in school
 - On the sports field
 - In the workplace
 - In restaurants, stores, theatres,...
- **If majority males experience "1.001" and others experience "0.999" the difference accumulates profoundly**
 - White males' experience $\rightarrow \infty$ ("1400" after 20 years)
 - Others' experience $\rightarrow 0$ ("0.00067" after 20 years)

Other tensions for Women in Science



- **Being oneself** *versus* fitting into the science culture
- **Making connections:** political relationships *versus* meaningful relationships and performance
- **Controlling your destiny** *versus* conforming to others' expectations ("Agency")
 - Moreover, expectations about women conflict with expectations about scientists and engineers
- **Achieving wholeness:** freedom to align your ideas, personality, and passions while being and being perceived as professionally successful
- **Gaining self clarity:** knowing what you need to do and be

Adapted from M. Ruderman and P. Ohlott: Standing at the Crossroads

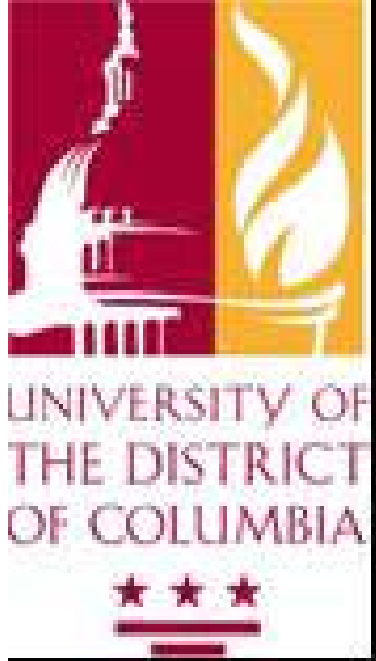
Engaging Girls and Women of Color



- **Even fewer role models ANYWHERE**
- **Lack of family members encouraging their mathematical, scientific, and intellectual growth and confidence**
- **Cultural disconnect from family**
- **Even more limiting gender-ethnic schema**
- **Non-minority women are often oblivious and unsympathetic to these challenges**
- **We must commit to understanding these issues and enabling their access and success**

“Women in Science Rule” from Student Mural at LIGO Louisiana





Thank you!

Questions?

Discussion?