Barriers and Proposed Solutions

Women in STEM: A Systematic Review and Analysis of the Literature

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Implications: Why We Need More Women in STEM

- STEM fields and careers are essential to the strength of the US economy—removing barriers to allow greater access to talented women would decrease shortage of STEM workers
  - Improved competitiveness of the US
- Many of major world problems are dealt with by STEM fields (e.g., global warming, sustainable energy sources, cancer and disease cures); demand for these workers is increasing
- Allows women to reach their full potential and act on their preferences; allows for greater access to a pool of talented individuals without the barriers
- Drawing more women into STEM fields increases pay (math-intensive jobs pay more)
  - Reduced gender wage gap
- Diversity; Results in greater innovation, productivity, creativity, and new perspectives toward old/outdated scientific approaches among STEM fields

Brief Overview of Causal Factors across the STEM Pipeline

- Leaky Pipeline Metaphor: Represents the route from early education to a career in STEM, spanning from kindergarten (early formative years) to adulthood (career establishment), from which women are lost at each stage.
  - Small leakage at each stage results in comparatively fewer women in STEM careers, and various gaps at each stage (e.g., exam scores, undergraduate major, employment gap, job gap, ijob gaps such as promotional and leadership gaps)

- **Social Role Theory** Expectation of men to display agentic qualities and women to display communal qualities
  - Learning of gender roles at a very young age, enacting continual influence on women throughout adulthood
- **Lack of Support**
  - Lack of Mentorship
  - Lack of Role Models
    - Occurs during elementary school years with teachers (majority of whom being female) who may perpetuate this gender stereotype of men being more successful in mathematical disciplines (i.e., acting it out themselves)
- **Lack of Confidence in Ability**
  - **Parent Expectation of Ability/Unqualified or Ineffective Teachers** teacher and parents' gendered perception of student abilities may result in imbalanced learning environment girls interest in math/science may be discouraged belief may be put onto students
  - **Innate Skills/Abilities** Despite similar mathematical abilities, certain innate abilities may be elicited and strengthened by teachers based on gender; e.g., small gaps in math ability (potentially stemming from aforementioned factors of social role theory and lack of support) may influence teachers choice in working more closely/devoting more time with male students regarding math; in effect further widens the gap
    - **Comparative Advantage** women's superior reading/writing performance compared with men; may steer interest towards humanities fields
    - **Warmth versus Competence** men seen as competent and women seen as warm ordinarily assessed as opposing traits

Brief Overview of Causal Factors: Adolescence and Early

- **Negative stereotypes of women's quantitative abilities**; Ultimate potential result: devaluation/discouragement from persistence in STEM fields
  - **Stereotype Threat** anxiety experienced in which individuals fear being judged regarding a group-based stereotype; may affect cognitive resources needed to perform successfully
    - Potentially results in reduced performance among math science classes, driving girls away from STEM classes altogether
- **Lack of Confidence in Ability**
  - **Lack of Opportunity** in STEM Topics/Fields throughout high school years (consequence of stereotype threat induced discouragement); may result in reduced self esteem in science/math skills, overall warding off women from entering STEM fields (e.g., taking fewer math/science classes) in future college years
- **Lack of interest**—experienced during early college years as women are choosing major
  - **Preferences and Choices**
    - **Constrained**
      - **Microinequities**: (e.g. microaggressions, perception of being different) may impact self concept, stress, and feelings exclusion in STEM fields, resulting in influence in career choice
    - **Freely Made**
      - **Narrow Focus** often an emphasis on logical thinking rather than critical thinking in STEM disciplines; e.g., STEM students are seldom asked to think about the societal implications (e.g.,public welfare) and importance of their STEM field/discipline as well as why it is needed neglect of this line of critical thinking often persists into STEM careers as well
        - Women may be disproportionately discouraged from STEM fields if a clear social purpose is not perceived
- **Clustering**: Women tend to cluster in certain fields (e.g humanities and social sciences rather than STEM fields); as a ultimate consequence, comparatively more women graduate with a humanities field degree

Brief Overview of Causal Factors: Undergraduate/Graduate, Job Searching Years

- **Social Network**; social networks typically less helpful among women regarding employment opportunities (e.g., greater difficulties job searching, receiving less interviews compared with those who "know somebody")
- **Evaluative Bias**
  - **Sexist Hiring**; male candidates viewed as more hirable and competent, presenting greater difficulties for women among becoming hired in STEM job, even once given the interview

Brief Overview of Causal Factors—Career Establishment

- **In-Job Evaluative Biases**
  - Promotion
  - Salary
  - In-Group Favoritism
- **Role Congruity Theory of Prejudice**—incongruity between gender and a particular role or occupation can result in negative evaluations
- **Lack of Confidence in Ability—Imposter Syndrome**—belief of being unqualified or fear of being revealed as a "fraud"
- **Glass Ceiling**—greater difficulty among women to advance to higher positions and take on leadership roles within their job
- **Lack of Support**
  - **Family/Work Balance Struggle**—disproportionate expectation of fulfilling home/family responsibilities; inflexible work structures and policies posing challenges for women with children
  - **Isolation**; disproportionately perceive employer/supervisor to be unavailable, and perception of lack of voice at work
  - **Queen Bee Effect**—among women, perception of oneself as accomplished among ordinarily male-dominant disciplines, viewing oneself as better/different than other less accomplished women
    - Refusal to assist/mentor "less accomplished" women, and critique female subordinates in a way that is harsher
  - **Black Sheep Effect**—reluctancy of accomplished women to assist those women early in their career lacking experience as well as a fully developed skillset
- **Harassment in Work Environment**
- **Discrimination**
  - **Implicit and Explicit Bias**; both influence behavior towards women and men
    - Ultimate end result: potential career switch among women

Proposed Solutions Created to Remedy Causal Issues alon

- **Early Childhood Years:**
  - Introduce Role Models
    - As a means of alleviating stereotype threat and lack of role models and mentorship
    - Exposure to other talented women in STEM may increase self confidence in ability
    - Targets potential effects of social role theory, stereotypical image of individuals in a STEM career as men, and negative stereotypes of women's quantitative abilities
    - Teaches girls that academic fields of science and math are welcoming and suitable for them
- **Adolescence and Early Adulthood**
  - Using self-affirmation to alleviate the stereotype threat
    - As a means of reducing lack of confidence in ability, increasing interest (e.g., reduced microinequities) and allowing for greater opportunity in STEM disciplines, and therefore decreased clustering;
    - May then lend itself to choosing of a career in STEM
- **Post-Undergraduate/Graduate, Job Searching Years**
  - Implement affirmative action policies and diversity initiatives
    - Reduced harassment in work environment via greater institutional climate/cultivation of feelings of a community
    - Reduced evaluative biases: sexist hiring, promotion, salary, ingroup favoritism, glass ceiling
    - Ultimately increases retention rates in STEM job/career
- **Post-Career Establishment**
  - Introduce implicit and explicit bias training as a means changing individual's behaviors
    - As a means of targeting harassment in work environment via favorably affecting department climate, more flexible work structures and policies for women with children; aids in struggle between balancing family and work, and increases feelings of having a voice (for instance, greater confidence in mentioning family/personal matters during scheduling), decreasing discrimination (implicit and explicit bias) and isolation, and increasing women's social network

Additional Suggestions for Future Research and Intervent

- Strong internal validity at the expense of external validity; typical use of experimental design over correlational design
  - Small sizes of effect
    - A single intervention is unlikely to be sufficient in solving such a multifaceted problem.
    - Insufficiency of time frames; inability to weigh the full practical significance of its respective intervention against the costs of time, money, and effort needed to implement it.
  - Population: reduced applicability to intended age group at its respective stage in the pipeline
    - Importance of targeting the birthplace of a gap prior to its cumulative widening; testing of intervention after the harmful effects have transpired is less effective
    - Use of convenience sampling—systematic differences result in reduced generalizability
  - Bias reduction interventions' use of proxy measures; measurement of implicit, attitudinal biases rather than true behavioral change