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The Shared Experiences of Non-Traditional Groups in Academic STEM Disciplines

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MSU-Facility for Rare Isotope Beams

Virtual Nuclear Science Seminar

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  - Future Workforce Directions Space Operations Assessment Team
  - Women Leadership Development-OPE Curriculum Development Team
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Significance

- The results of this effort resulted in the identification of factors that can be used as a conceptual framework for establishing institutional conditions and a work environment across higher education institutions that support women's advancement and retention in academic appointments of leadership related to STEM disciplines and workplace education.
- The research considers relevant literature related to current institutional strategies and predictors for women's success and retention in STEM disciplines.
- Such an exploration addresses challenges of non-traditional groups, specifically gender inequity issues regarding women's advancement in STEM.

Areas of Focus in Current Literature

STEM Pipeline:

1. STEM Professionals
2. Gender equity in secondary and postsecondary STEM disciplines
3. Persistence and retention of women in STEM

The Advancement and Hinderance Factors of Women in STEM:

1. Stereotype threat
2. Societal gender bias
3. Psychology of women in STEM leadership positions

Cultural Change in Academia:

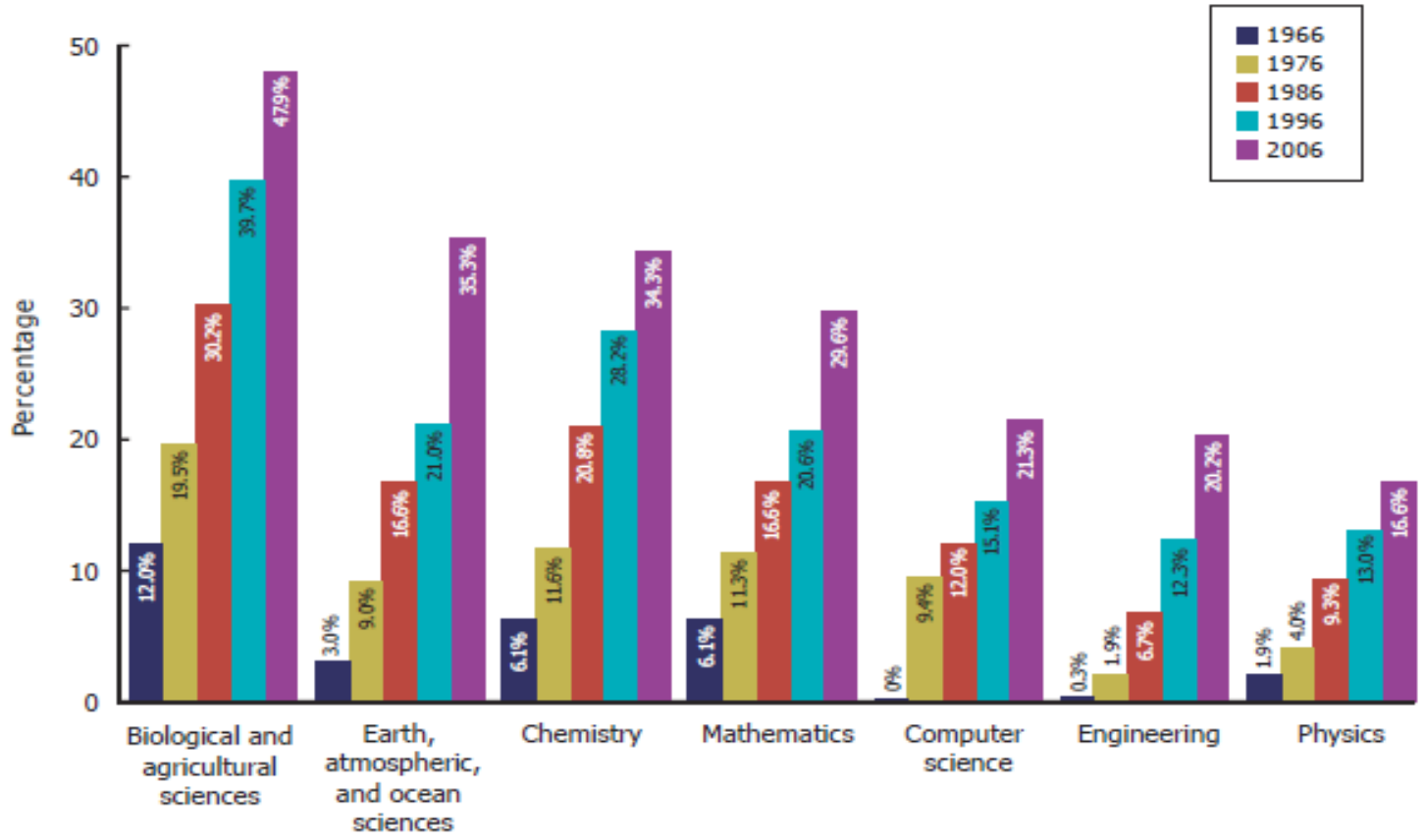
1. Perceptions of female faculty in STEM
2. Viable advocates
3. Persistence and retention of women in STEM

The Role of the Institution

1. Faculty and administrative perceptions
2. Policy review and reform
3. Institutional types
4. Workplace environments

Women's representation among STEM doctorates has also increased dramatically over time, although it varies by field.

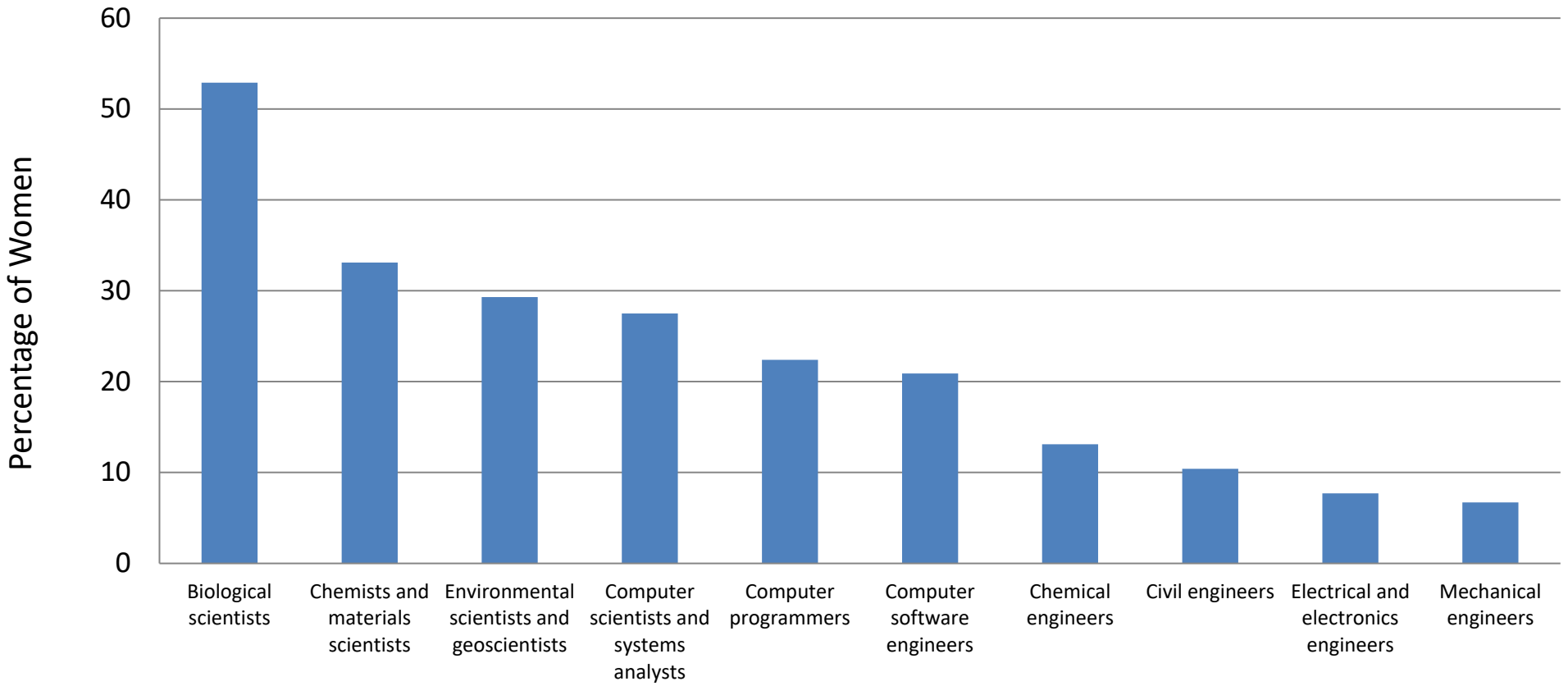
Doctorates Earned by Women in Selected STEM Fields



Source : National Science Foundation, Division of Science Resources Statistics of Tables 34, 35, 38, & 39. (NSF 08-321)

Women are underrepresented in many science and engineering occupations.

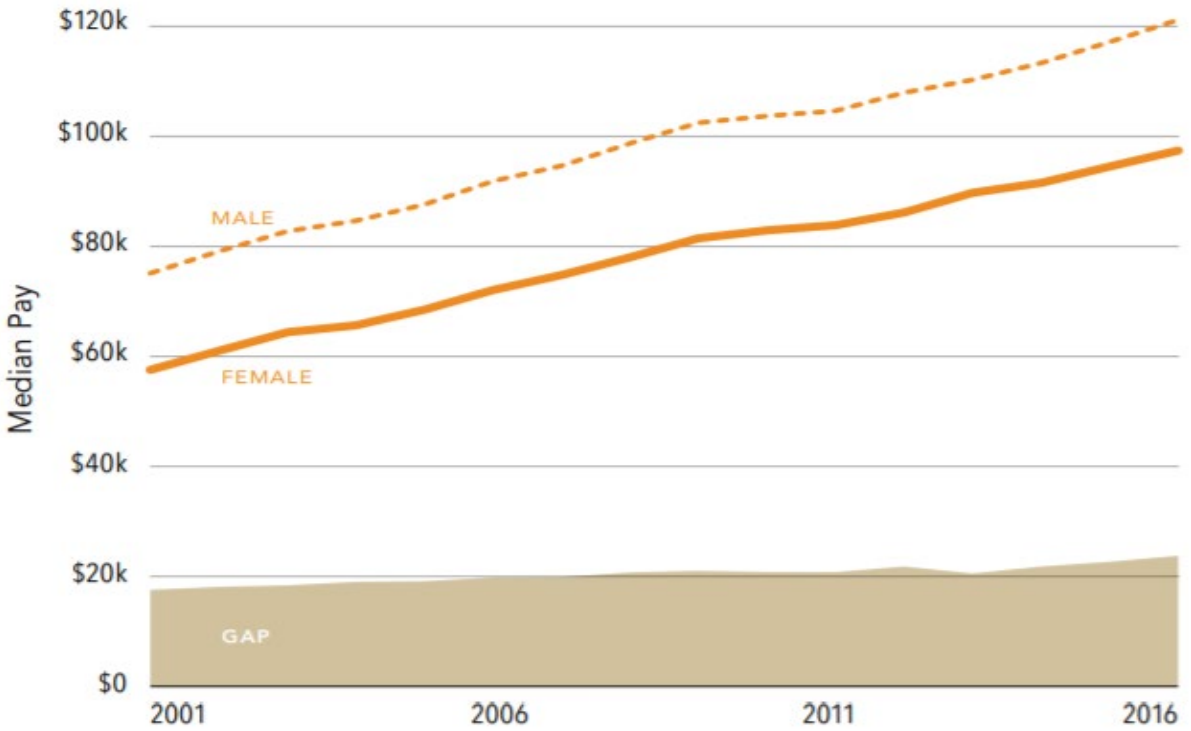
Percentage of Employed STEM Professionals Who Are Women, Selected Professions



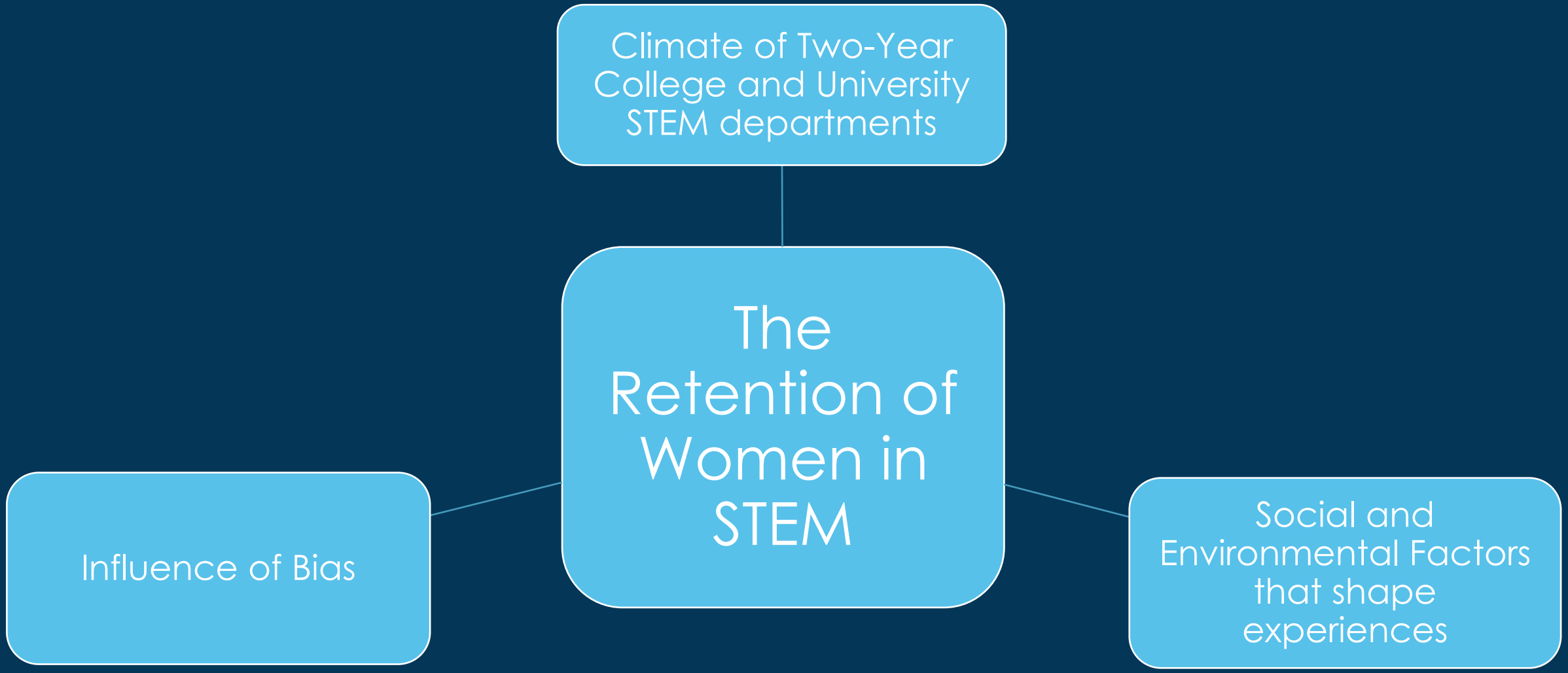
Source: U.S. Department of Labor, Bureau of Labor Statistics,
Women in the labor force: A databook (Report 1018; Washington, DC), Table 11.

Pay Gap

The *Chronicle of Higher Education* Almanac (2022) confirms shows that women earned only 85% to 87% of what male counterparts did. Salaries for both men and women have risen steadily since 2001. The chart below shows the gender pay gap over the past 15 years for administrators in higher education.



The Academic Conversation



Conceptual Framework: What factors contribute to women's abilities to advance in STEM leadership?

The study explored institutional conditions conducive to women's advancement and retention in STEM and workforce education in higher education such as:

- **Exposure for women to successful role models in math and science.**
- **Changes in institutional policy for more inclusive environments to challenge gender inequities.**
- **Monitoring the climate of science and engineering departments at colleges and universities to create inclusive programs for women.**
- **Providing mentoring and early career advising for junior faculty.**
- **Implementing effective work-life balance policies to support faculty.**
- **Challenging bias that limits women's advancement into STEM fields.**

RESEARCH QUESTIONS

This research was guided by two specific questions that were addressed through data collection and analysis:

1) What factors have the most impact on women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year degree offering institutions?

2) What factors inhibited women's professional advancement and success in leadership positions within STEM and workforce education-related disciplines at two-year degree offering institutions?

METHODS

RESEARCH DESIGN

Delphi Technique

The questionnaires were guided by the survey design and follow Schmidt's (1997) framework for ranking factors in the panelists' responses. The study included four rounds:

R1) identifying factors related to both research questions;

R2) consolidating the list of factors identified by the panelists and identifying any additional factors missing from the list.

R3) rating the list from most relevant to least relevant as it relates to the research questions;

R4) obtaining group consensus on the final factors that were previously identified and rated.

SAMPLE POPULATION

1) Former and current administrators who oversee STEM and workforce education related programs at two-year degree offering institutions

Panelists were asked to self-disclose information regarding their current and previous roles in administration within STEM and additional qualifications such as experiences and research background in STEM-disciplines

2) Active members in a national or regional STEM organization and programs that promotes broadening participation of women in STEM.

3) Female

4) Must have held a Ph.D. or terminal degree in their STEM-related field.

SELECTION CRITERIA

An initial purposive sample of 10 former and current administrators identified by the researcher were invited to participate in the study based on their qualifications.

A snowball sampling technique was used to recruit additional eligible panelists from among their peers based on established criteria.

A minimum of 20 panelists were selected to participate in the first round to adjust for attrition effects in the second and third rounds to ensure a minimum of 10 respondents within the last round.

DESCRIPTION OF THE SAMPLE

- An introductory email was sent out to the most appropriate individuals to serve on the panel based on their expertise and career longevity within STEM and understanding of issues related to leadership and gender equity within STEM fields.

- 28 emails were sent out by Feb. 24th, 2019.

- 20 panelists agreed to participate in the study

- Panelists were asked to include specific demographic information to confirm their name, their affiliated institution that offered two-year degree programs, their former or current administrative role in STEM or a workforce education related field.

DESCRIPTION OF THE SAMPLE

The STEM clusters:

- Mathematics (6)
- Workforce education (4)
- Health (3)
- Engineering (2)
- Aeronautics (1)
- Environmental sciences (1)

Round 1 representation included 17 out of 20 (85%)

Administrative positions included

- Deans within a STEM academic discipline (8)
- Principal investigators and directors who served in administrative roles and oversaw federally-funded STEM and STEM-related workforce education programs (6)
- Assistant Vice Presidents over STEM and workforce education related programs (3)

RESULTS

Round 1

- Panelists were instructed to provide two to three factors and a few sentences describing each factor or related experience for context.
- A review committee categorized the factors by similarities and themes and consolidated them to 22 factors total.
- The factors identified included 10 supporting advancement and 12 inhibiting advancement.

Round 2

- Panelists were asked to review the categorized list of factors and either confirm their approval of the list or add additional factors if necessary.
- On April 5, 2019, 17 panelists were emailed and 12 responded without changes and five panelists responded with modifications and additional factors.
- The number of related factors and description increased from 10 to 13 factors that support advancement and 12 factors that inhibit advancement for a total of 25 factors.

Round 3

- The panelists opinions were requested to rate the importance and/or relevance of each factor identified and/or modified in Rounds 1 and 2 of the study.
- The rating scale used a five-point Likert-type scale with a numeric value (e.g. 5 points= Most Relevant Factor, 4 points= Significant Relevant Factor, 3 points= Moderate Relevant Factor, 2 points = Limited Relevant Factor, and 1 point= Not Relevant Factor
- On April 21st, 2019, 17 panelists were emailed and 15 panelists responded (88%).

Round 4

The panelists had the opportunity to change their ratings in Round 4 after considering their individual ratings in Round 3 compared to the group mean (*M)*, median (*Mdn), IQR*, and standard deviation (*SD)* for each factor.

Although the group median and mean will be presented to the panelists in Round 4, the researcher established a factor as relevant based on a mean score of 3.50 or higher on the 5.00 scale based on Delphi studies that used a similar cut off score as appropriate (Kosloski & Ritz, 2016; Martin & Ritz, 2012; Pate, Warnick, & Myers, 2012).

Round 4

- Consensus by the panelists had been reached for 24 of the 25 factors (96%).

The researcher established that consensus was reached for any factors with an interquartile range of 2.00 or below based on similar studies that used 2.0 as an acceptable cut off score (Childress & Rohodes, 2006; Kosloski & Ritz, 2016).

Factors with an interquartile range (IQR) over 2.0 indicates that consensus was not gained due to the high dispersion of the ratings for each factor.

Relevant Factors Identified

RQ 1: 9 of 12 factors reached a 3.5 or higher for factors that support advancement

- Support Systems, *M* 4.40
- Personal Attributes, *M* 4.13
- Willingness to Advance, *M* 4.07
- Leadership Skills, *M* 4.00
- Curiosity about New Experiences, *M* 3.73
- Role Models, *M* 3.73
- Opportunities for Leadership Roles, *M* 3.67
- Experiences in Undergraduate and Graduate, *M* 3.67
- Awareness for Institutional Environment, *M* 3.60

RQ 2: 3 of 12 factors reached a 3.5 or higher for factors that inhibited advancement

- Conflicting Family Obligations, *M* 4.00
- Lack of Compensation, *M* 3.67
- Personal Concerns, *M* 3.53

DISCUSSION

Discussion of the Findings

The results of the Delphi study can be used to inform administrators and researchers in higher education on the relevant factors concerning organizational climate, institutional policies, and departmental conditions that impact women's advancement or hinder their advancement in STEM fields.

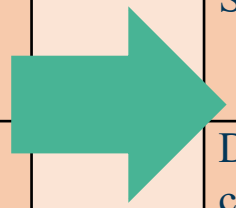
Through the four rounds of the Delphi study, **50% (12 or 24)** of the identified factors were considered relevant and reached consensus by the panelists.

The identified factors such as Conflicting Family Obligations (*M* 4.0) can drive conversations between educators and policy makers in the designing high-quality programs and organizational support for women aspiring to be in leadership roles in STEM and workforce education-related programs.

Policies regarding family-friendly work conditions with flexible hours can be considered so women don't feel they will be passed over for promotion due to conflicting scheduling issues and personal concerns.

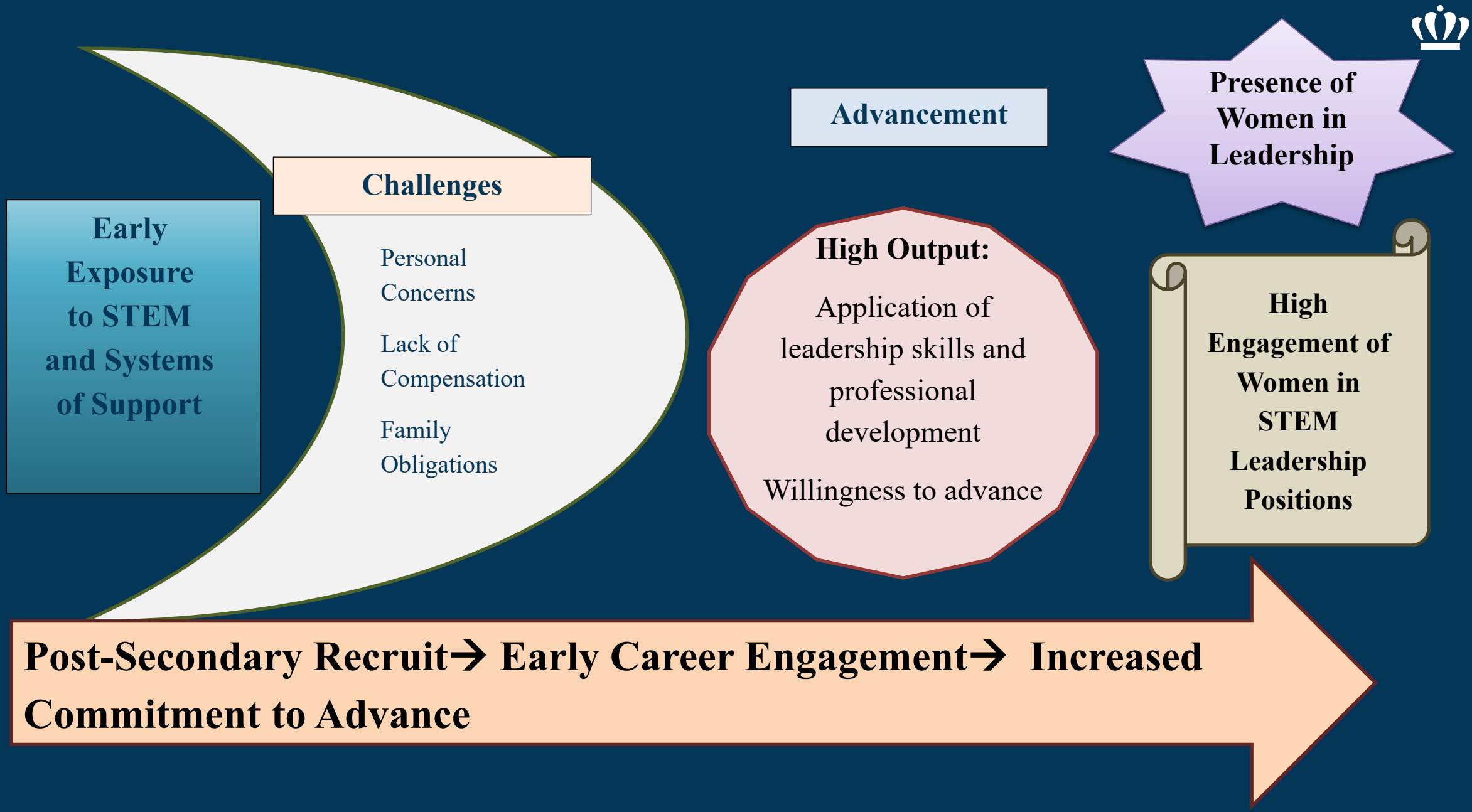
Theoretical Framework Guiding the Study

Recent Graduates	Early and Mid- Career Transitions	Context of Support	
Math and science self-efficacy builds	Intent and willingness to advance in STEM fields	Entrance into an overall STEM Community and Network of Support	Entrance into discipline specific STEM and workforce education positions of leadership
Exposure to career mentors and role models	Self-confidence and self-efficacy builds	STEM identity development through a support network and connection to STEM role models	Identity development and engagement in a community of STEM leaders
Early achievements and skills development in STEM leadership positions	Connection to STEM Community	Understanding of personal attributes that influence career trajectory	Development of leadership competencies and awareness of institutional environments
Support community of teachers and peers in graduate programs	Work-life integration	Exposure to career opportunities	Engagement in institutional systems of support



Context of Barriers

Life/Career Stages: Prolonged time to advancement and limited recognition for work achieved along the STEM pathway.
Social and Cognitive Development Needs: Conflicting family obligations and detachment from a STEM community; Limited support and lack of compensation from institutions; Personal concerns and lack of connection to peers and faculty.


Early Exposure to STEM and Systems of Support
Challenges
Personal Concerns
Lack of Compensation
Family Obligations
Advancement
High Output:
Application of leadership skills and professional development
Willingness to advance
Presence of Women in Leadership
High Engagement of Women in STEM Leadership Positions
Post-Secondary Recruit→ Early Career Engagement→ Increased Commitment to Advance

LIMITATIONS

Only two-year institutions

Only academic settings

Only certain STEM fields were represented

Students and Industry representatives were not included

ASSUMPTIONS

* Panelists view advancement as a positive outcome in their career trajectory

* Panelists are aware of potential gender inequity and other gender equity issues cite in the literature.

* Factors that impact women's advancement and success as well as hinder advancement can be determined by experts serving in position of leadership

* Panelists are accurately representing themselves with regards to eligibility for the study requirements

QUESTIONS

References

Baumgartner, M. S., & Schneider, D. E. (2010). Perceptions of women in management: A thematic analysis of razing the glass ceiling. *Journal of Career Development, 37*(2), 559-576.

Bilimoria, D., & Xiangfen, L. (2012). *Gender equity in science and engineering*. New York and London: Routledge.

Dalkey, N.C. (1972). The Delphi method: An experimental study of group opinion. *Futures, 1*(5), 408-426.

Hill, C., Corbett, C., & Rose, A. (2010). Why so few? Women in Science, Technology, Engineering and Mathematics. Washington, DC. American Association of University Women.

Kosloski, M. F., & Ritz, J. M. (2016). Research needs: Career and technical education. *Career and Technical Education*. *41*(2), 117-140.

Su, X., Johnson, J., & Bozeman, B. (2014). Gender diversity strategy in academic departments: Exploring organizational determinants. *Higher Education*, *69*(5), 839-858. doi.org/10.1007/s10734-014-9808-z