

*Revitalizing Graduate STEM
Education for the 21st Century:*
Skills, Motivation, and Structure

DAVID F. FELDON, PH.D.

NOVEMBER 7, 2017

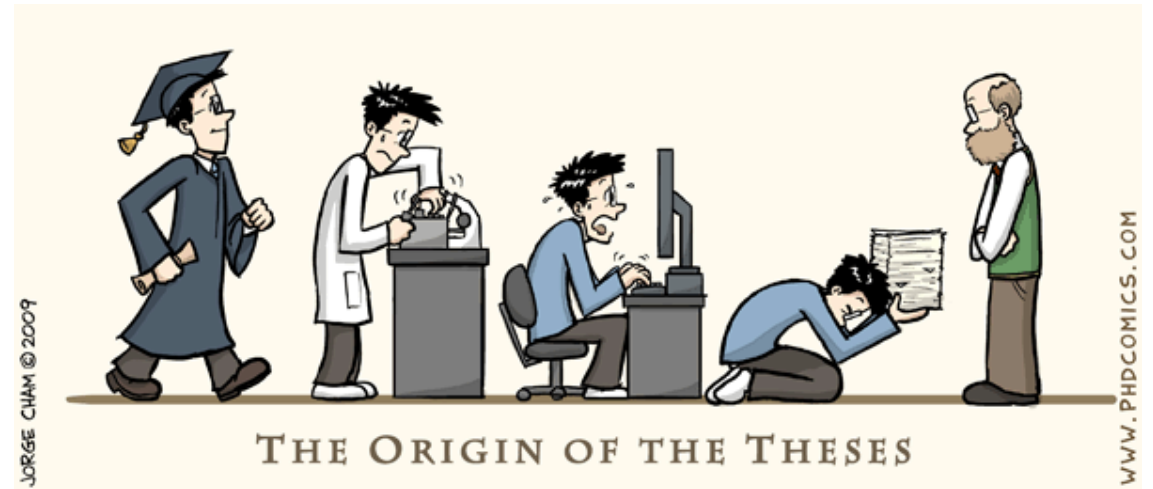
Premises of the PhD

Knowledge and skill development

- Theory
- Methodology
- Current state of the field

Acculturation

- Learn and use the language of the academy
 - Publication
- Social and collaborative networks



Three-Career Model (Laudel & Gläser, 2008)



Cognitive Career

- Skills
- Knowledge Claims



Community Career

- Citations
- Awards
- Reputation



Organizational Career

- Access to necessary resources
- Compensation
- Benefits

THE AUTHOR LIST: GIVING CREDIT WHERE CREDIT IS DUE

The first author
Senior grad student on the project. Made the figures.

The third author
First year student who actually did the experiments, performed the analysis and wrote the whole paper. Thinks being third author is "fair".

The second-to-last author
Ambitious assistant professor or post-doc who instigated the paper.

Michaels, C., Lee, E. F., Sap, P. S., Nichols, S. T., Oliveira, L., Smith, B. S.

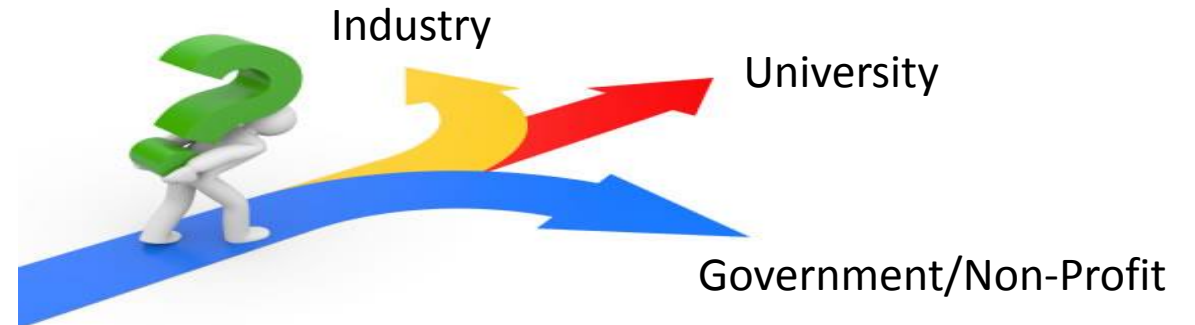
The second author
Grad student in the lab that has nothing to do with this project, but was included because he/she hung around the group meetings (usually for the food).

The middle authors
Author names nobody really reads. Reserved for undergrads and technical staff.

The last author
The head honcho. Hasn't even read the paper but, hey, he got the funding, and his famous name will get the paper accepted.

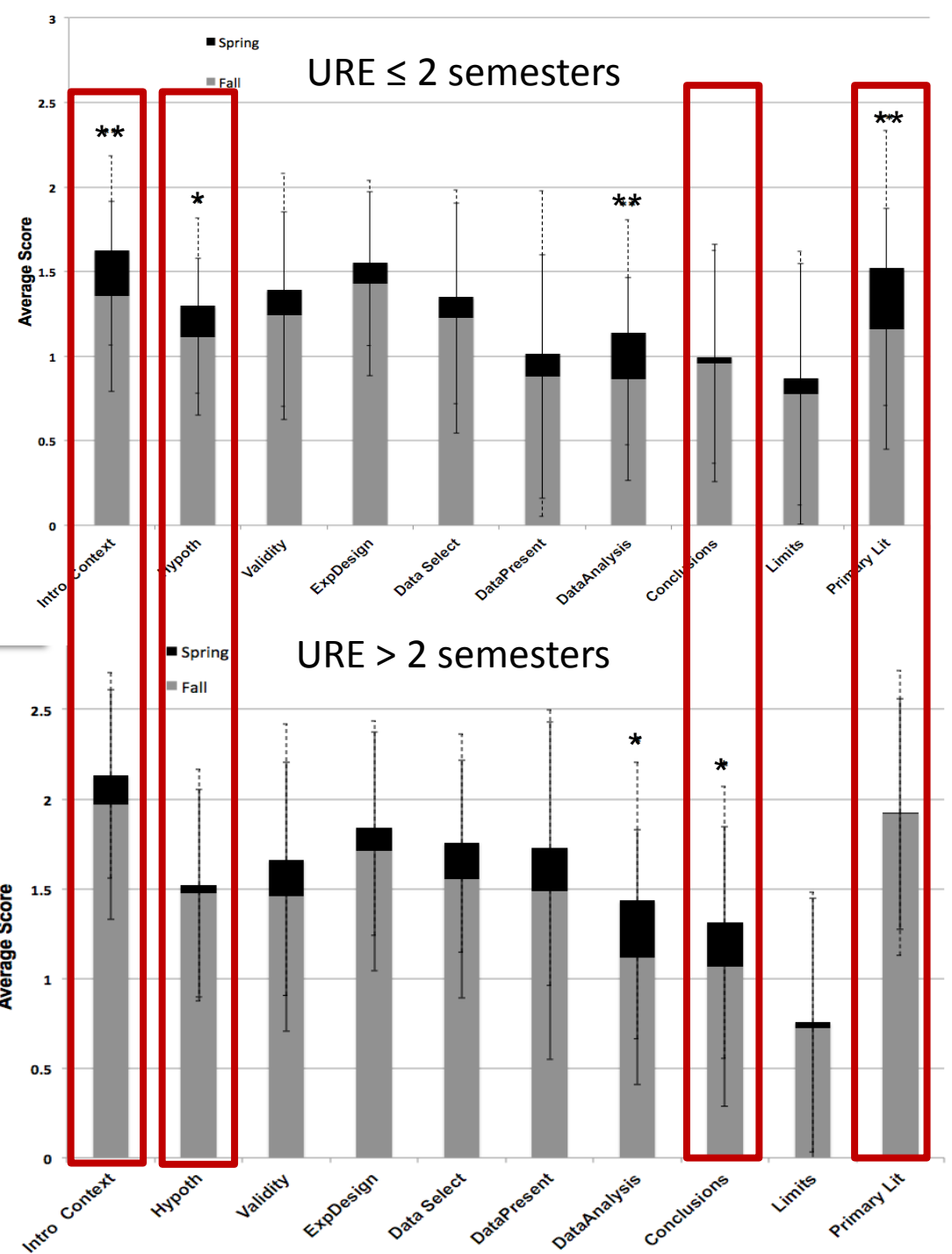
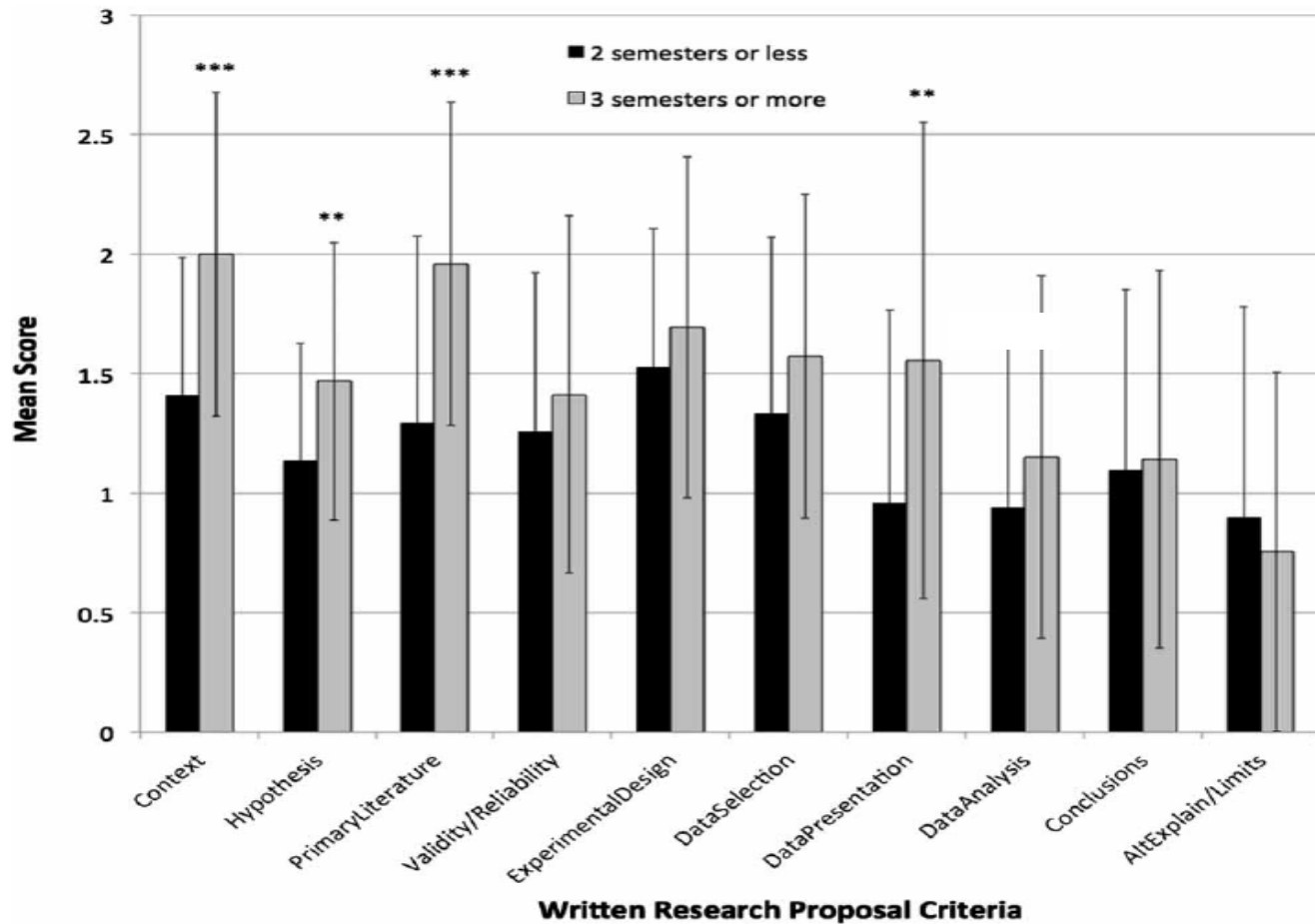
VORGE CHAM © 2005

www.phdcomics.com



Cognitive Career

Research Skills Develop Sequentially



Equity-Trajectory Interaction

Significantly less participation in undergraduate research with faculty for (Kim & Sax, 2009):

- African Americans
- First-generation college students
- Students from lower socioeconomic backgrounds

Latent growth models in current study (Feldon et al., in prep.):

- First-generation students have significantly lower skills at PhD program outset
- Same students demonstrate significantly greater (positive) slope for skill growth over time

Effective Practices for Developing Skills

Diverse training experiences

- Teaching + Research (Feldon et al., 2011, *Science*)
 - Medium effect sizes
 - Testability of Hypotheses ($d = 0.40$)
 - Experimental Design ($d = 0.48$)
- Student-Faculty Coauthorship (Feldon et al., 2016, *IJR*)
 - Medium effect size ($\Delta R^2 = 0.068$)

Do Bootcamps and Summer Bridge Programs Help PhD Development? (Feldon et al., 2017, *PNAS*)

Participation (n=46 of 286; 16%) did **not** predict:

- Research skill scores or gains ($0.3 \leq p \leq 0.9$)
 - Data analysis and writing skills ($0.7 \leq p \leq 0.9$)
- Publication rates or gains ($0.5 \leq p \leq 0.8$)
- Socialization scores or gains ($0.1 \leq p \leq 0.9$)
 - Campus Climate & Commitment (Nora & Cabrera, 1996)
 - Perceived Cohesion Scale (Bollen & Hoyle, 1990)
 - Research Experience Self-Ratings (Kardash, 2000)
 - Socialization of Doctoral Students to Academics (Weidman & Stein, 2003)

Do Skill Gaps Close Overall? (Feldon et al., 2016, *AERJ*)

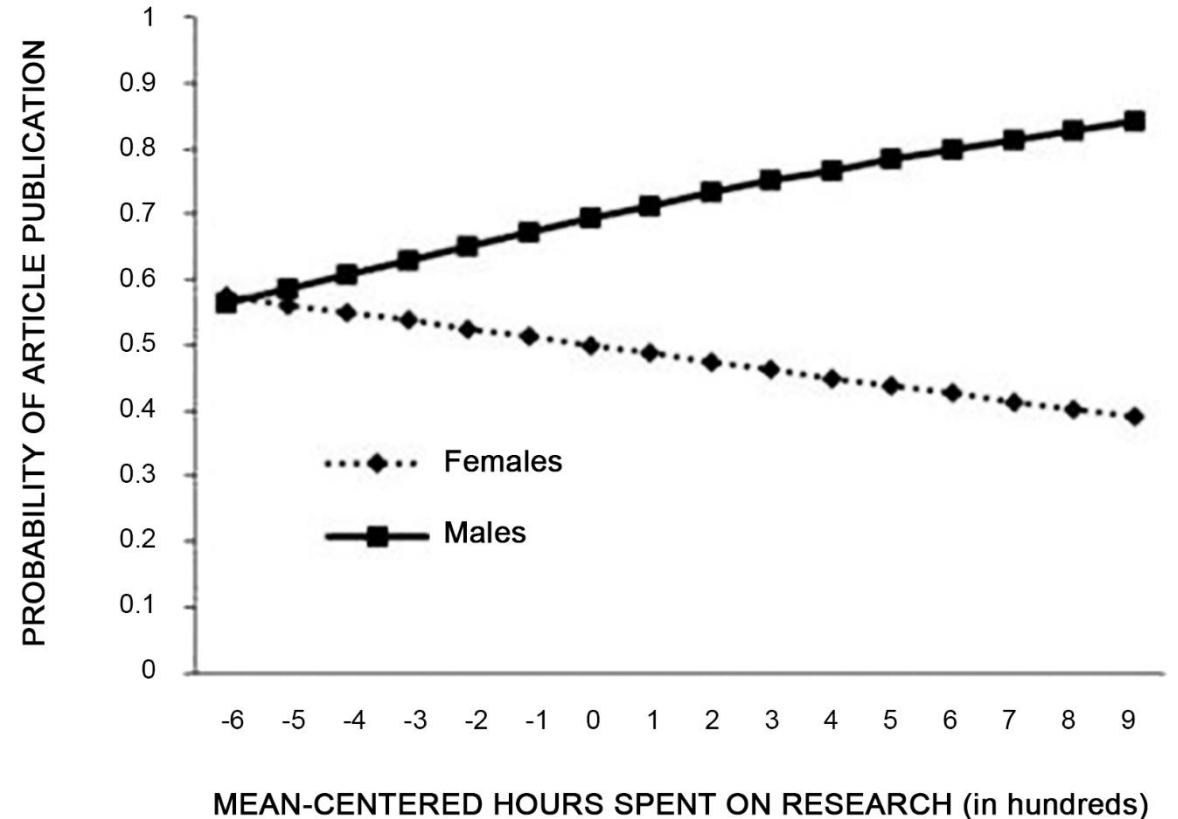
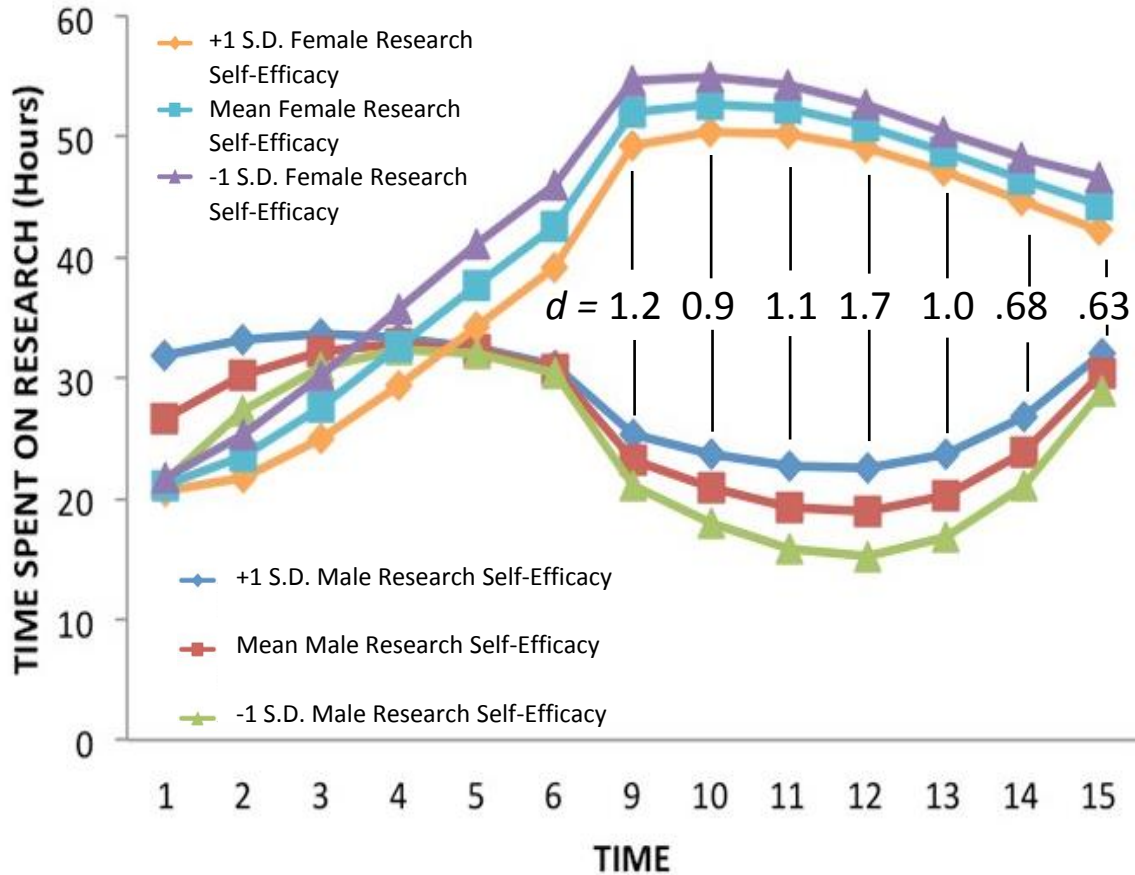
Skill gaps widen, but not based on mentor access

- High performers and low performers are farther apart after two semesters on every measured skill, even after controlling for pre scores ($0.001 \leq p \leq 0.03$; $0.54 < d < 1.01$)
- All students received comparable mentoring
 - Equally positive relationships with faculty advisors
 - Equally high advisor expectations of research activity
 - Equal rates of coauthorship with advisor
- Differences between groups:
 - High performers' advisors held clear expectations of self-direction and productivity
 - Low performers' advisors held more flexible expectations
 - High performers are more independent decision-makers
 - Low performers are less likely than high performers to value mundane tasks (e.g., data collection)

Community Career

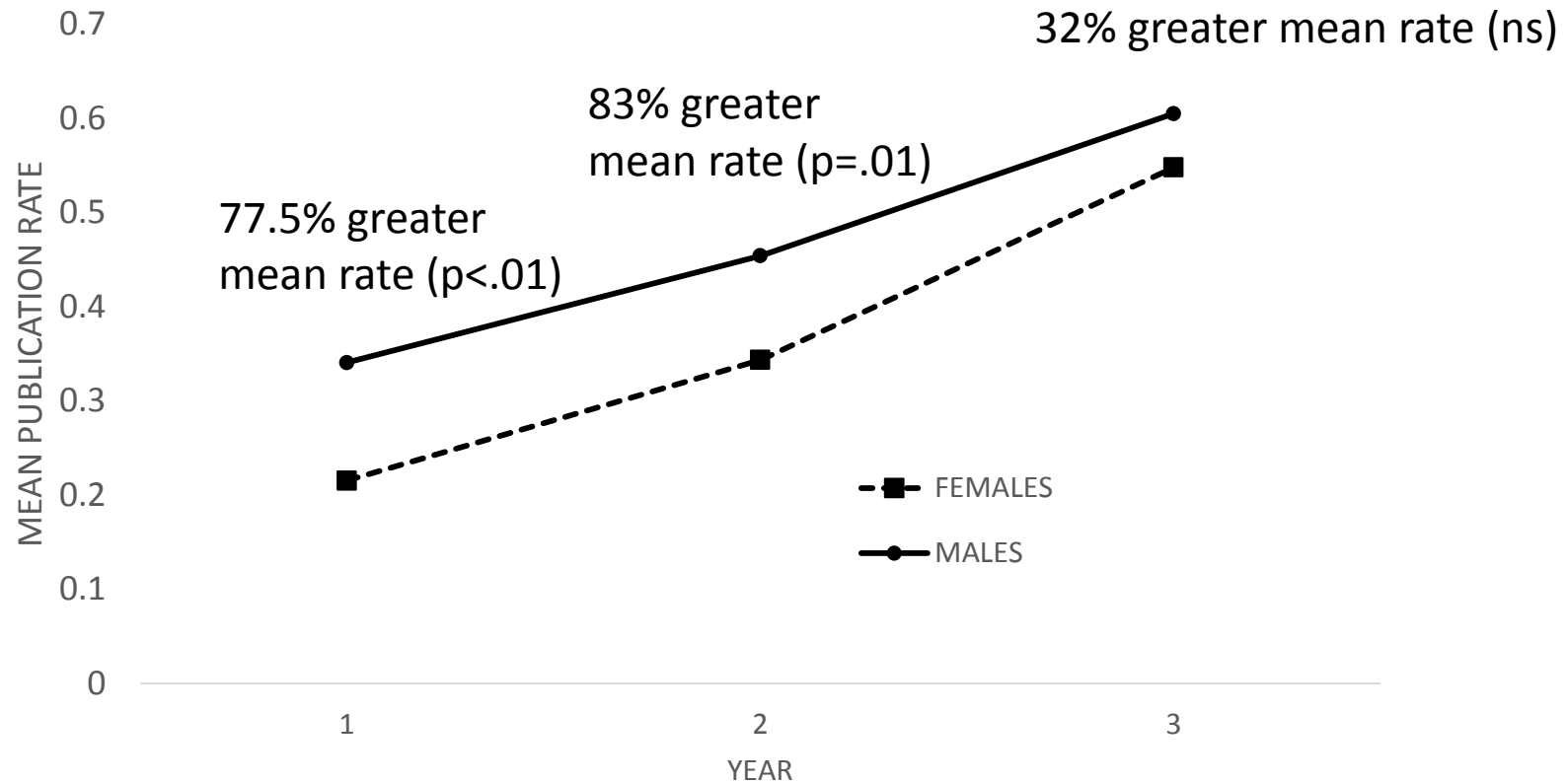
Time-to-Credit Gender Inequities in Publication

(Feldon et al., 2017, *CBE-Life Sciences Education*)



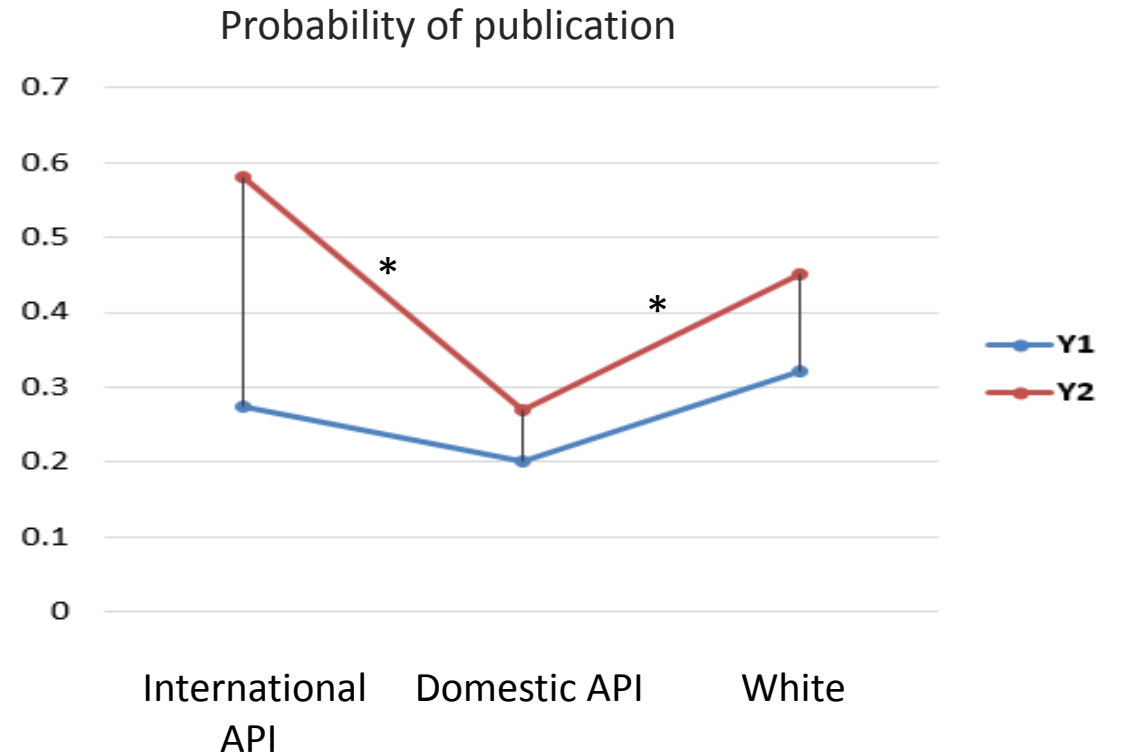
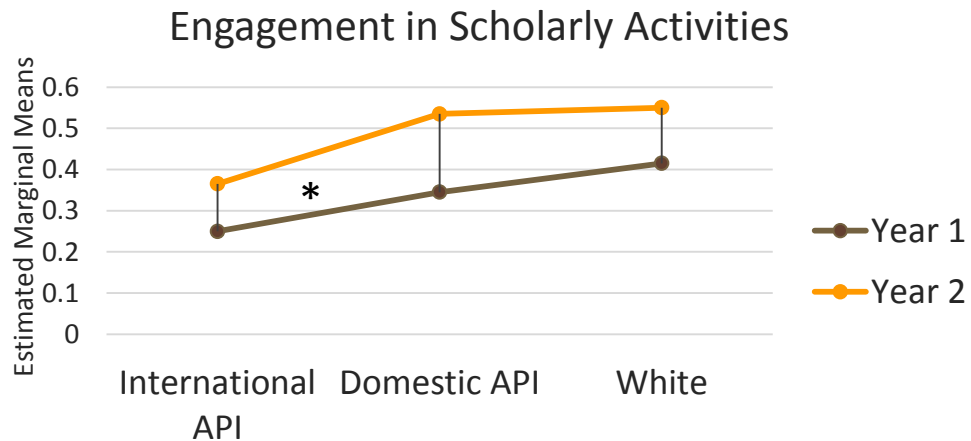
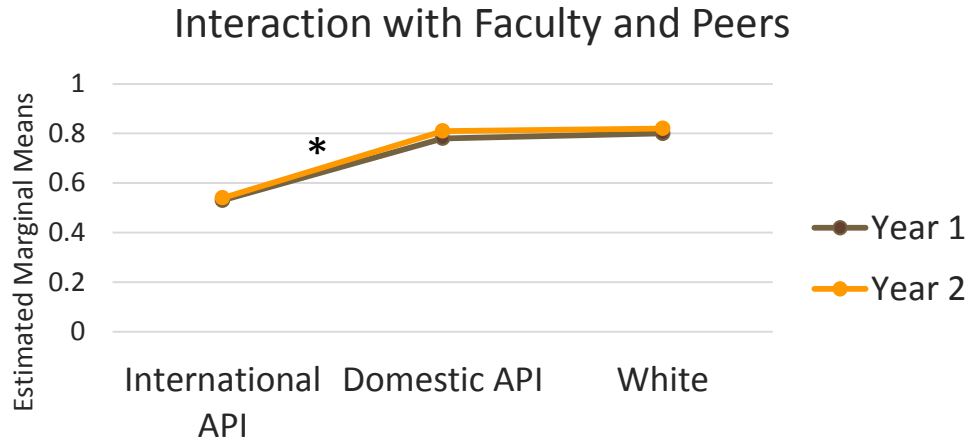
Publication Rates by Gender

(Feldon et al., in preparation)



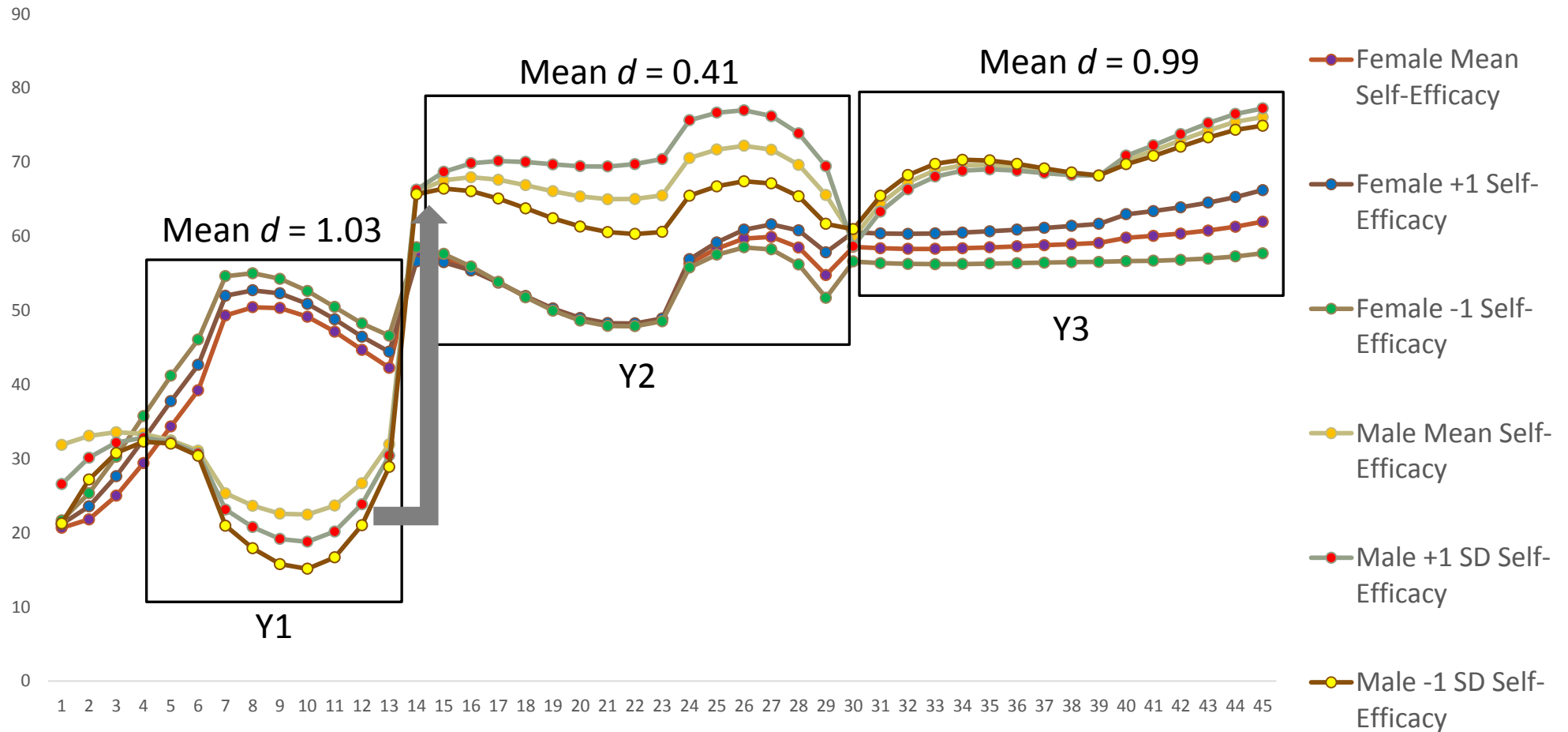
Socialization Does Not Drive Productivity

(Roksa et al., in press, *RSE*)



Organizational Career

Lab Time by Gender Over 3 Years



Laboratory Rotations as a Target of Future Inquiry (Maher et al., 2017, *JCSR*)

During exit interviews with students withdrawing from Ph.D. programs during the first 2 years of study (n=18), 33% reported “Rotation 180”

- Positive interactions and experiences during rotation, negative interactions after placement
- 5 of 6 were female
- Supervising faculty of both genders

Acknowledgements

Jie Chao, Joana Franco, Joanna Gilmore, Soo Jeong, Michelle Maher, Michael Oliva, James Peugh, Josipa Roksa, Alok Shenoy, Kathan Shukla, Vincent Sun, and Briana Timmerman



This material is based upon work supported by NSF under Grants 1431234, 1242369, and 0723686. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of NSF.