

Webs of Science: Mentor Networks Influence Social Integration into STEM Careers

Society for the Advancement in Biology Education Research
(SABER)

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Overview

- Introduction
- Understanding disparities in STEM field participation
- Mentorship in college STEM contexts
- Study Contexts & Methods
- Effects of:
 - Faculty Mentors on Outcomes
 - Mentorship Networks on Outcomes
 - Inputs on Mentorship Network Formation and Maintenance
- Recommendations

Brief Introduction

- 2019-present: Associate Professor, Texas A&M University
- 2014-2019: Assistant Professor, West Virginia University
- 2013-2014: Assistant Professor, Colorado State University
- 2011-2013, Postdoctoral Research Associate, Colorado State University
- 2011, Ph.D. in Educational Psychology, University of Connecticut
 - Measurement, Evaluation, and Assessment
 - Quantitative Research Methods (Psychology)

My Personal & Professional Mission

Better understand the **relationships** and **experiences** that support motivation and persistence in higher education – particularly for students from historically underrepresented groups pursuing science and engineering degrees and careers.

STEM Fields have a Big Problem

Some of the most important and urgent challenges facing society are related to Science and Engineering problems, including disease burden, energy, and climate change.

Many STEM fields have the low levels of diversity at all levels of higher education and in the workforce. (NSF, 2021)

Lack of diversity limits innovation, equity, and societal relevance. (Campbell et al., 2013; Valentine and Collins, 2015).

Some Barriers to Diversifying STEM Fields

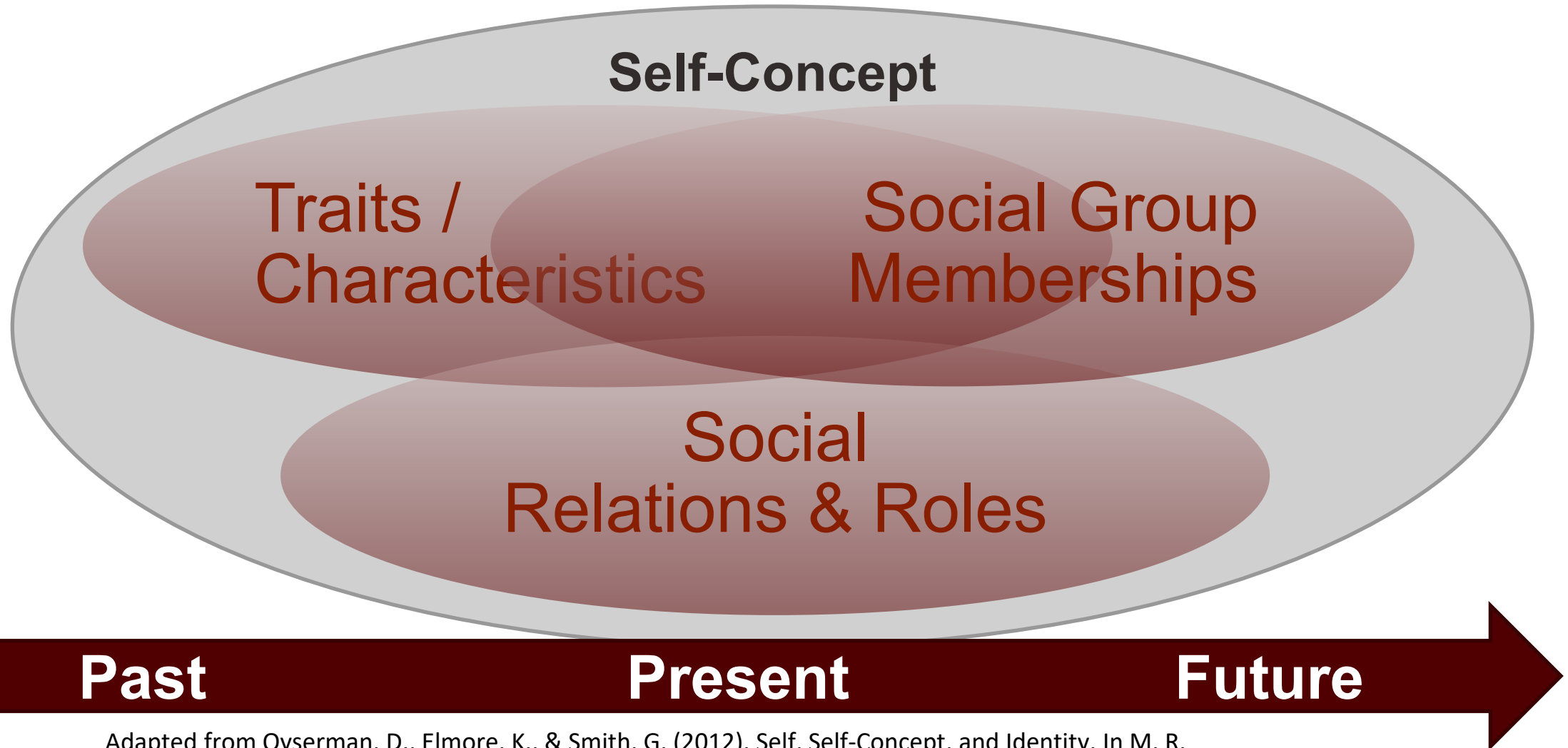
Social and cultural factors can discourage people from under-represented groups from the pursuit of STEM degrees/careers. (Cheryan and Plaut, 2010; Cheryan et al., 2015)

Barriers include negative cultural stereotypes about:

*Dissimilarity with the people,
Incongruity with the work, and
Incongruity with the social values.*

Social and cultural factors can influence self-identities, identity-congruence, and ultimately self-concept. (Oyserman et al. 2012)

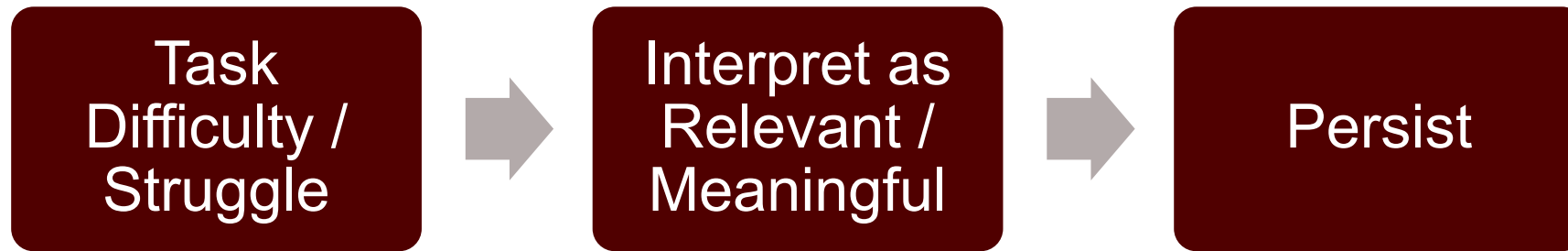
Self-Concept and Identities



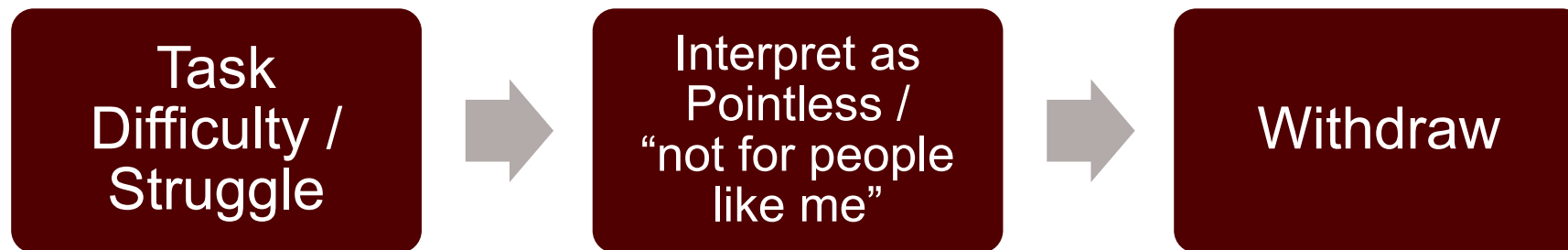
Adapted from Oyserman, D., Elmore, K., & Smith, G. (2012). Self, Self-Concept, and Identity. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of Self and Identity (Second Edition ed.)*. Guilford Publications.

Identity-Based Motivation

- Identity-Congruent Situations



- Identity-Incongruent Situations



Adapted from Oyserman, D., Elmore, K., & Smith, G. (2012). Self, Self-Concept, and Identity. In M. R. Leary & J. P. Tangney (Eds.), *Handbook of Self and Identity (Second Edition ed.)*. Guilford Publications.

Mentoring

Mentoring viewed as a potential solution to STEM persistence gaps

(Linn et al. 2015; NASEM, 2017, 2019)

Mentors can provide support, information, and resources that draw people into their discipline. (Hernandez et al., 2017, 2018a, 2018b, 2020)

- Psychosocial / Emotional Support
- Instrumental / Career Support
- Networking
- Co-authoring Opportunities
- Role Modeling
- Protection from of Negative Interactions

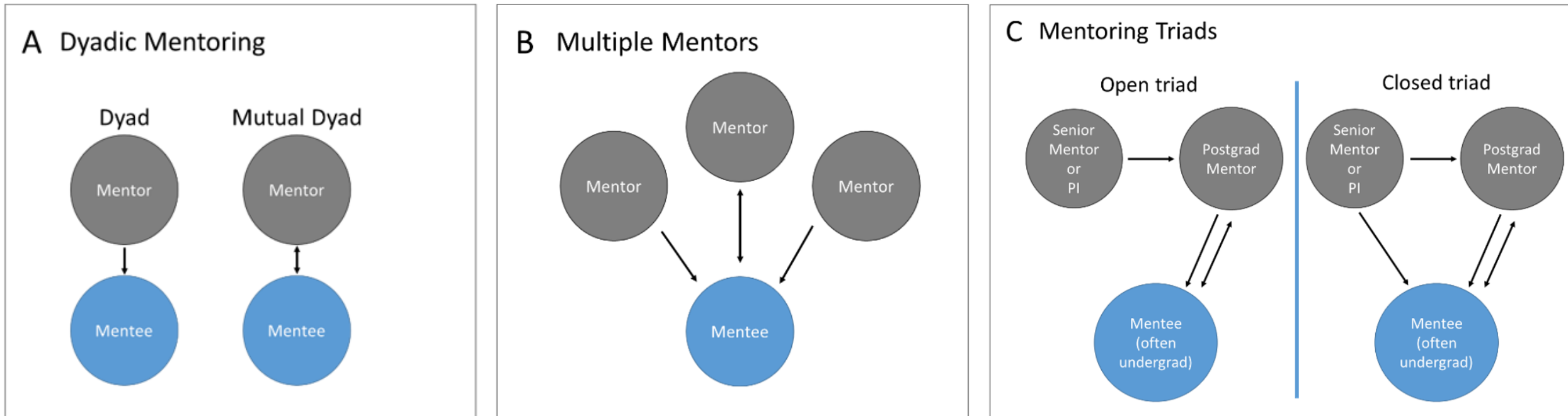
Positive and counter-stereotypic STEM career role models support STEM-identity, STEM-identity congruence, motivation, performance, and persistence. (Cheryan et al., 2013; Cheryan et al., 2011; Clark et al., 2016; Herrmann et al., 2016; McIntyre et

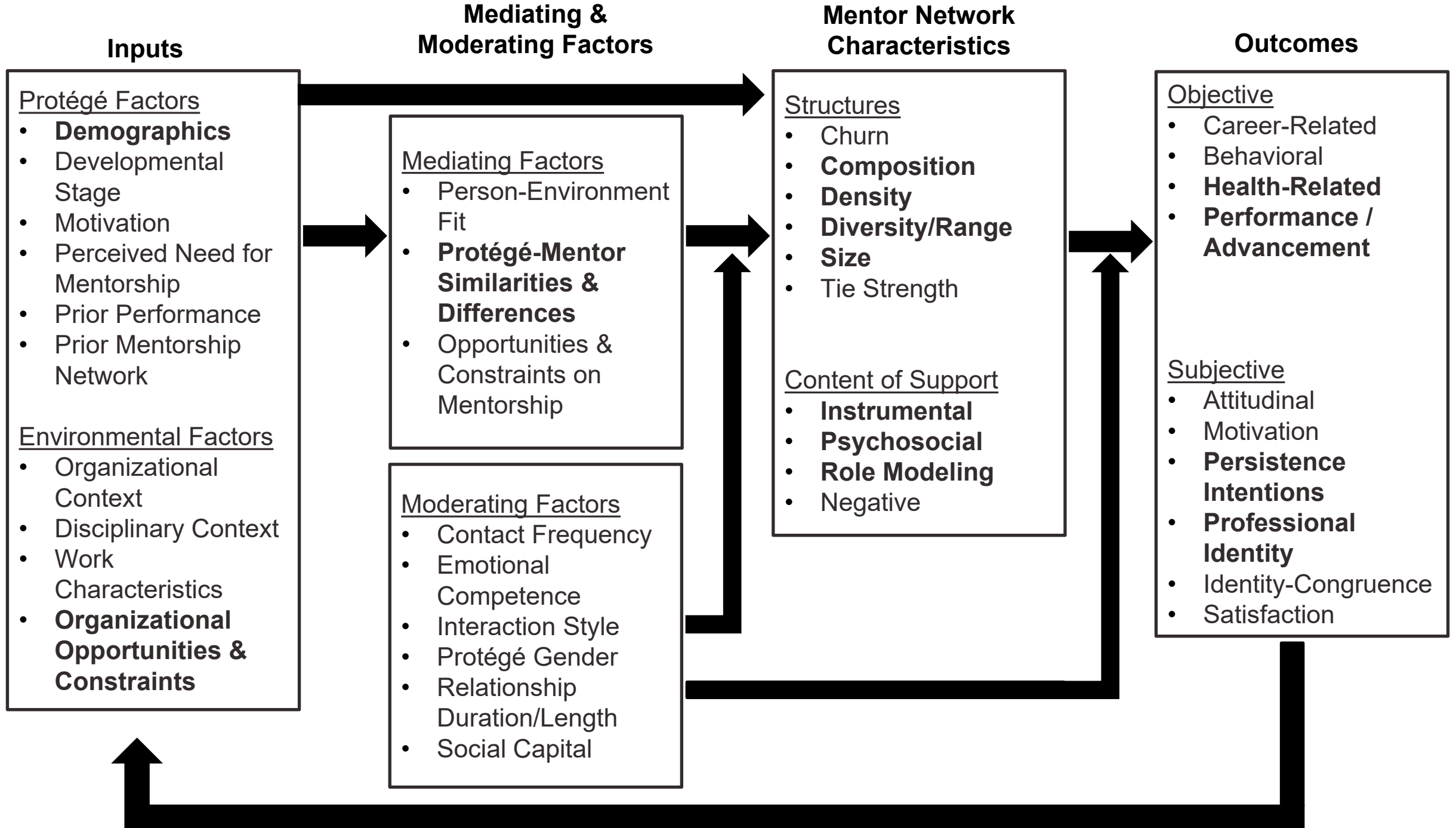
al., 2005; Rosenthal et al., 2013; Shin et al., 2016; Young et al., 2013)

Developmental Mentor Network Theory

(Higgins & Kram, 2001)

- Critique – dyadic mentoring models do **not** adequately describe or explain the impacts of mentorship. (NASEM 2019)





Study Contexts & Methods





The Science Study

Supported by the National Institutes of Health

- Large-scale (N = 1,420), prospective, propensity matched control
- Quasi-experimental, longitudinal study of R.I.S.E. students. Launched in 2005, completed in 2017.
- Participants from 25 programs nationwide
- Twice yearly surveys from students
- Matched control group
 - For each R.I.S.E. student, we find a similar student who does not go through the program
 - Matching variables: ethnicity, gender, major, GPA, intention to become a scientist, enrollment level (LD, UD, Grad)
 - Secondary matching: age, parental education, community college transfer, English as first language

Longitudinal Panel



72% Female

Ethnicity/Race:

- 49% African American
- 39% Hispanic/Latinx
- 11% Mixed/Other
- 1% Native American

Major (at Wave 0):

- 63% Biological Sciences
- 21% Physical Sciences
- 12% Behavioral & Social Sciences
- 4% Mathematics & Engineering

PROGRESS

PROMoting Geoscience Research, Education, and Success

- Longitudinal Quasi/Experimental designs (2014-2019)
- Diverse undergraduate women STEM majors interested in earth & environmental science careers
- 9 Universities
- Activities:
 - Weekend workshop (Kickoff event)
 - Follow-up with on-campus informal mentor(s)
 - Interaction through social media (website and private Facebook page)
 - On-campus and online networking and mentoring events (e.g., Identifying and applying for a summer research experience).

Longitudinal Panel

- Race/Ethnicity
 - 68% White or Asian
 - 32% from historically under-represented minority groups in STEM
- College Rank at baseline
 - 51% First year
 - 49% Sophomore
- Followed over 4 years from college and beyond

Research Focus

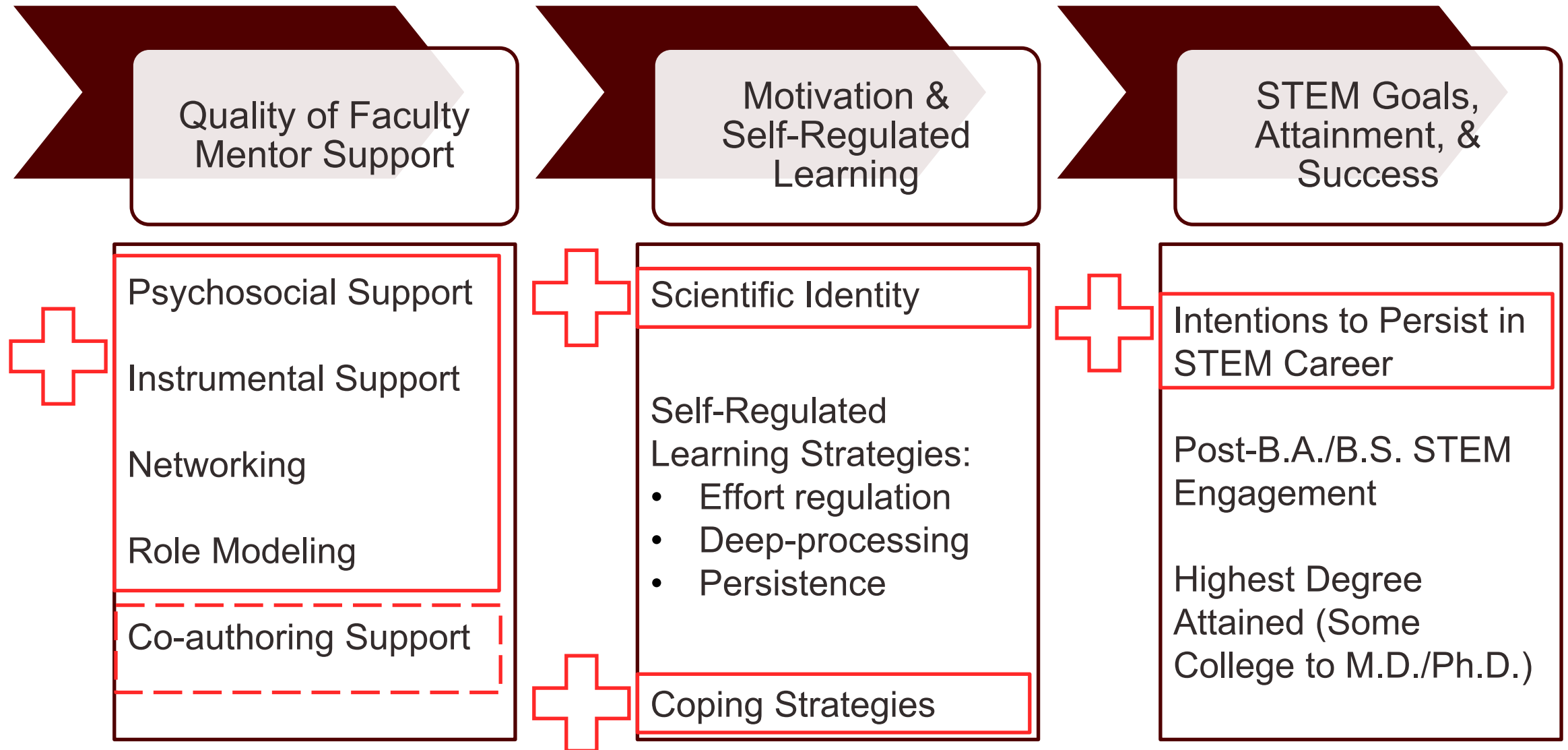
1. Effects of Faculty Mentors on Outcomes
2. Effects of Mentorship Networks on Outcomes
3. Effects of Inputs on Mentor Network Formation and Maintenance

Effects on Student Outcomes

Faculty Mentoring



Hernandez et al. (2017a, 2017b, 2020), Pedersen et al. (2022)



Estrada et al. (2018)

Quality of Faculty
Mentor Support

Motivation &
Self-Regulated
Learning

STEM Goals,
Attainment, &
Success

+

Psychosocial Support
Instrumental Support
Networking

Role Modeling

Co-authoring Support

+

Scientific Identity

Self-Regulated
Learning Strategies:

- Effort regulation
- Deep-processing
- Persistence

Coping Strategies

Intentions to Persist in
STEM Career

+

Post-B.A./B.S. STEM
Engagement

Highest Degree
Attained (Some
College to M.D./Ph.D.)

Tise et al. (Under Review)

Quality of Faculty
Mentor Support

Motivation &
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BEYOND FACULTY: A HOLISTIC APPROACH TO MENTORING

Mentor Network Effects on Student Outcomes



Hernandez et al. (Accepted)

Mentor Networks

Motivation & Self-Regulated Learning

STEM Goals, Attainment, & Success



Support

Psychosocial

Career

Role Modeling

Structures

Size of Network

Density of Connections

Composition

- %Faculty
- %Grad. Students
- %Peers
- %Professionals Outside College



Scientific Identity

Self-Regulated Learning Strategies:

- Effort regulation
- Deep-processing
- Persistence

Coping Strategies

Intentions to Persist in STEM Career

Post-B.A./B.S. STEM Engagement

Highest Degree Attained (Some College to M.D./Ph.D.)

Hernandez et al. (Accepted)

Mentor Networks

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Motivation & Self-Regulated Learning

Scientific Identity

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Coping Strategies

STEM Goals, Attainment, & Success

Intentions to Persist in STEM Career

Post-B.A./B.S. STEM Engagement

Highest Degree Attained (Some College to M.D./Ph.D.)

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Mentor Networks

Motivation &
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STEM Goals,
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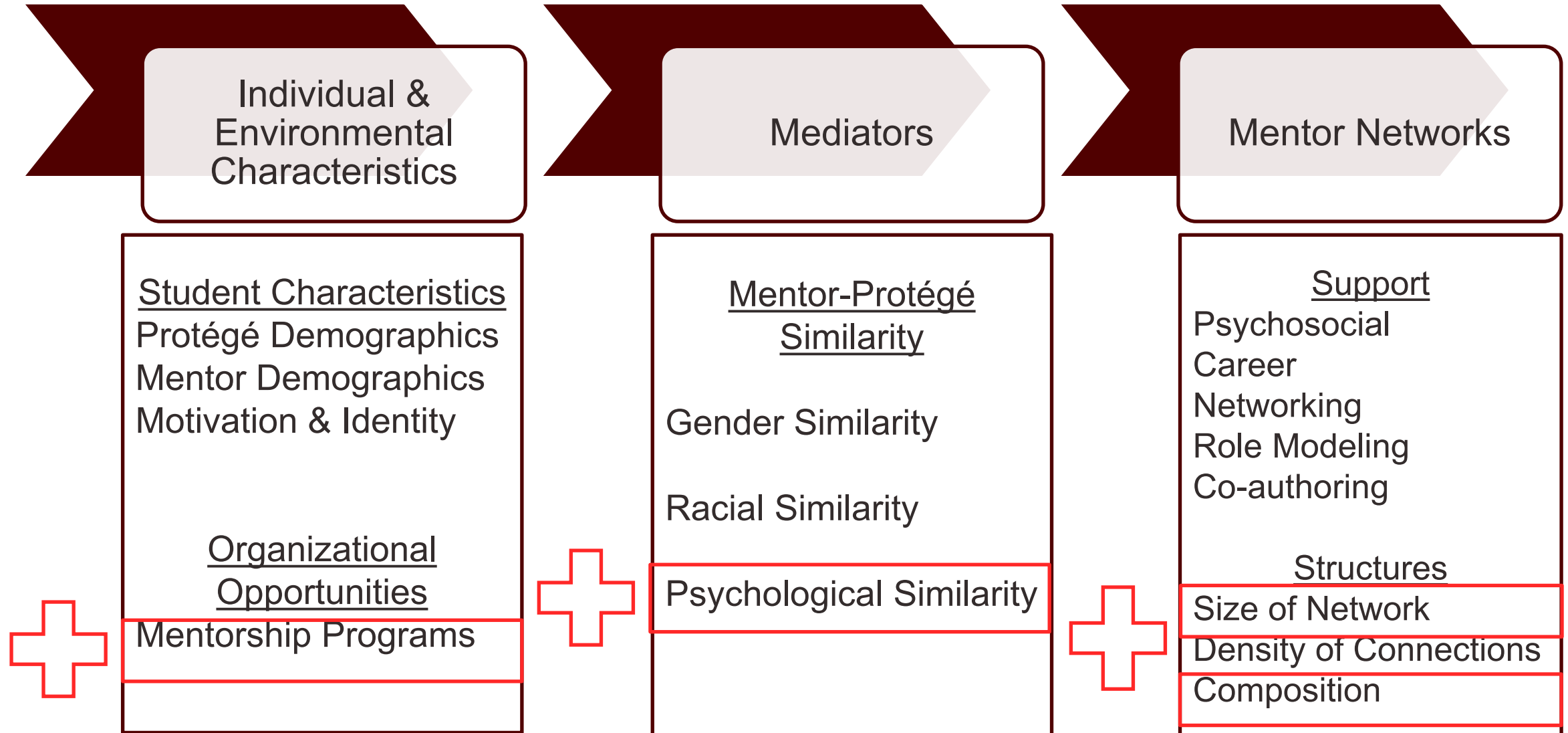
Faculty were key to building connections to others in the field (89%).

MENTOR NETWORK FORMATION AND MAINTAINENCE

Developing a Robust Network of Mentors



Hernandez et al. (2017a, 2020, 2023)



Hernandez et al. (2017b,
2023)

Pedersen et al. (2022)
Saw et al. (2022)

Individual &
Environmental
Characteristics

Student Characteristics
Protégé Demographics
Mentor Demographics
Motivation & Identity

Organizational
Opportunities
Mentorship Programs

Mediators

Mentor-Protégé
Similarity

Gender Similarity
Racial Similarity

Psychological Similarity

Mentor Networks

Support

Psychosocial
Career
Networking

Role Modeling
Co-authoring

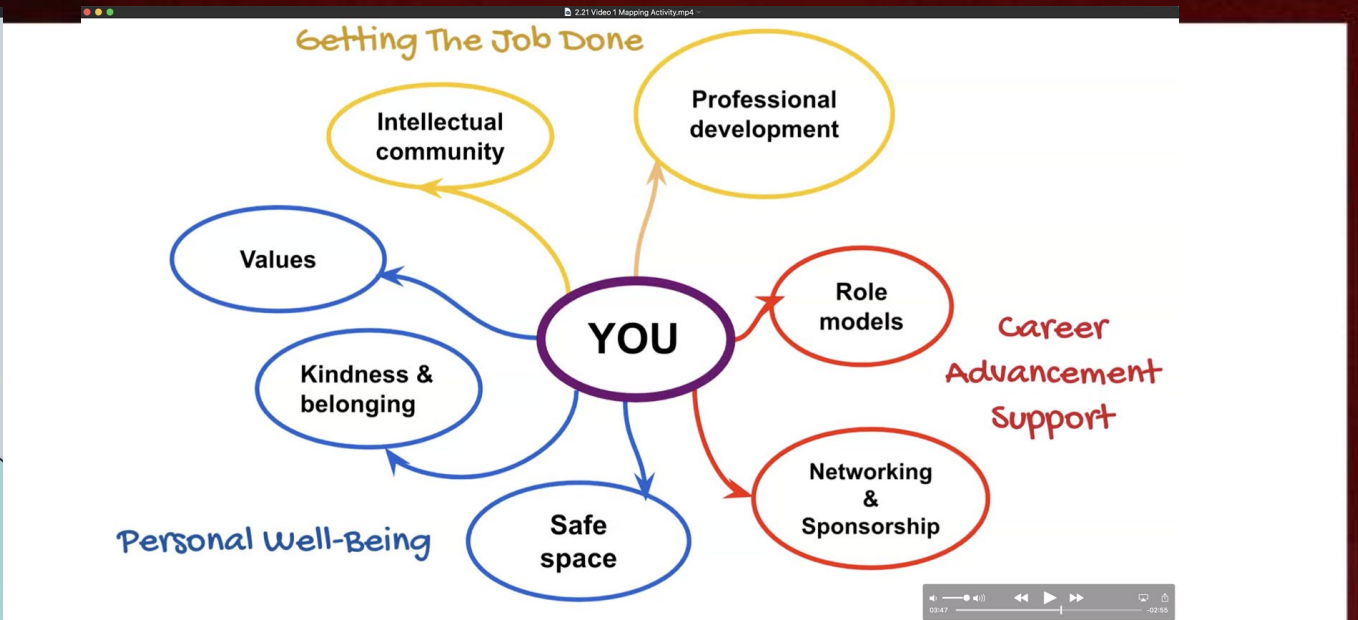
Structures

Size of Network
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Encouragement: Help Students Grow their Support Network

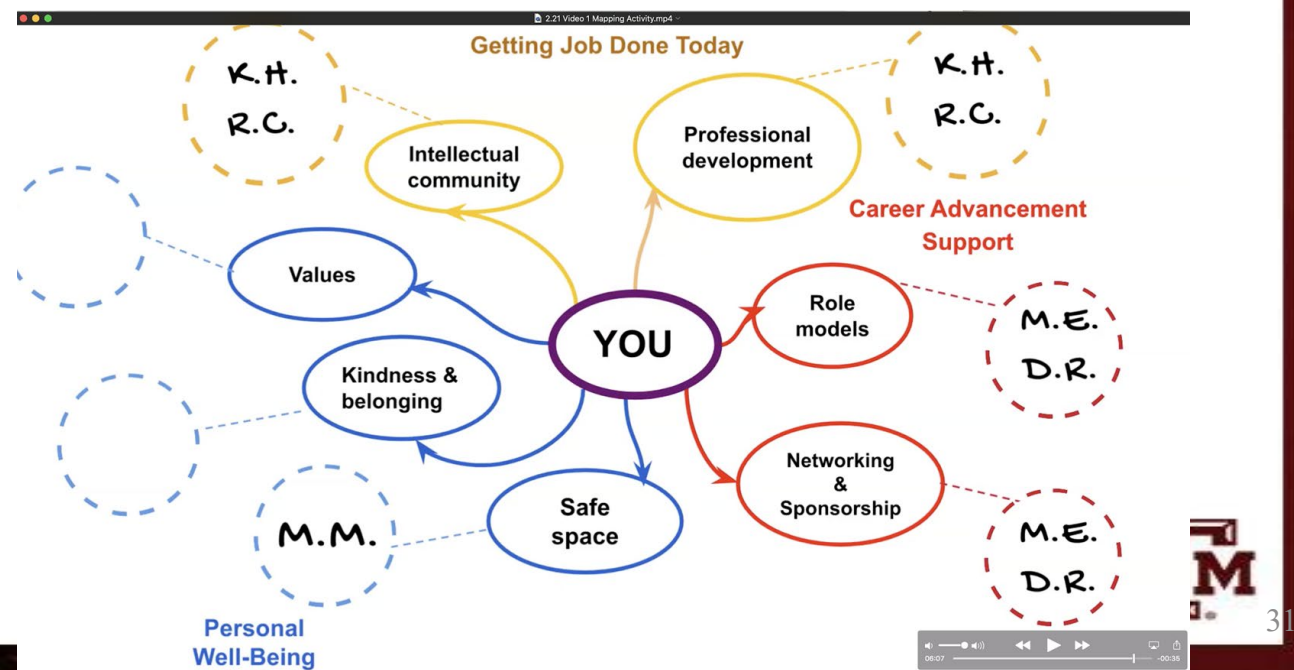
Practical Advice on Growing your Support /
Mentorship Network





Enter names and check the categories for which these people apply

	Intellectual Community	Professional Development	Role Models	Networking & Sponsorship	Safe Space	Kindness & Belonging	Values
Person 1: K.H.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Person 2: R.C.	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Person 3: M.E.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Person 4: D.R.	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Person 5: M.M.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Person 7:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Empower Students with Curriculum

TABLE 1. Entering Research conceptual framework and example activities^a

Areas of trainee development with learning objectives	Example activities
Research Comprehension and Communication Skills (RCC; 36% of curriculum)	
<ul style="list-style-type: none"> • Develop Effective Interpersonal Communication Skills • Develop Disciplinary Knowledge • Develop Research Communication Skills • Develop Logical/Critical Thinking Skills • Develop an Understanding of the Research Environment 	<ul style="list-style-type: none"> ○ Addressing Conflict ○ Aligning Mentor and Trainee Expectations ○ Prioritizing Research Mentor Roles ○ Your Research Group's Focus ○ Communicating Research Findings 3: Developing Your Presentation ○ Research Writing 1: Background Information and Hypothesis or Research Question ○ Research Writing 7: Research Paper
Professional and Career Development Skills (PD; 21% of curriculum)	
<ul style="list-style-type: none"> • Explore and Pursue a Research Career • Develop Confidence in Pursuing a Research Career 	<ul style="list-style-type: none"> ○ The Next Steps in Your Career ○ My Mentoring and Support Network ○ Research Careers: Informational Interview ○ Letter of Recommendation

Support Mentors Skill Development

Training session	Topic	Example learning objectives
Session 1	Introduction	Establish group dynamics and ground rules
	Effective communication	Identify different communication styles, learn multiple strategies for improving communication across diverse backgrounds
Session 2	Establishing expectations	Clearly communicate and align expectations, learn how differences in backgrounds may impact expectations
	Assessing understanding	Assess mentee's understanding, reasons for lack of understanding, and use strategies to enhance understanding
Session 3	Addressing diversity	Improve understanding of individual differences and cultures, identify concrete strategies for addressing issues of diversity
	Fostering independence	Employ strategies to build mentee's confidence, establish trust, and foster independence
Session 4	Promoting professional development	Develop strategies for guiding professional development and recognize and engage in open dialogue on balancing the competing demands, needs, and interests of mentors and mentees
	Articulating your mentoring philosophy and plan	Reflect on training experience and any intended changes of behavior or mentoring outlook, articulate approach for working with mentees in the future

Table 1. Overview of mentor training for clinical and translational researchers including topics and example learning objectives for each training session.

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National Institute of
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TEXAS A&M
UNIVERSITY.



National
Science
Foundation



Thank you!

Questions?

