Webs of science: mentor networks influence women's integration into STEM fields

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Mentorship can be part of the solution to developing a more diverse global scientific workforce, but robust longitudinal evidence is limited. Developmental mentor network theory can advance our understanding of the impact of a wide range of mentors across social contexts by distinguishing between the content of mentorship support (eg career support) and the structural characteristics of an individual's mentor network (eg density of connections among mentors). We tested the influence of mentor network characteristics on longitudinal social integration into the Earth and environmental sciences, as indicated by science identity development (a key indicator of social integration) and graduate-school applications in STEM (science, technology, engineering, and mathematics)-related fields of study, based on a sample of 233 undergraduate women at nine universities in the US. Our findings indicated that belonging to close-knit, larger, and skill-focused mentorship networks creates a "sticky web" of social connections, providing information and resources that increase retention of college women in the Earth and environmental sciences.

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Diversifying the global scientific workforce is critical (Valantine and Collins 2015). Recent studies have shown that like many science and engineering disciplines, the Earth and environmental sciences struggle to attract and retain talented emerging scientists from historically underrepresented groups based on gender identity, race/ethnicity, sexual orientation, and (dis)ability status (Beck *et al*. 2014; NCSES 2017). Mentorship is increasingly seen as an important process for achieving a more diverse scientific community (NASEM 2019). In college-level science, technology, engineering, and mathematics (STEM) contexts, receiving high levels of psychosocial and career mentorship support is associated with beneficial subjective (such as holding a strong science self-identity, a key indicator of social integration and motivator for science career pursuit) and objective (such as academic achievement) outcomes (NASEM 2019). However, robust evidence of the impact of mentoring on scientific professional development is limited, as most previous studies either failed to evaluate long-term impacts or confounded research experiences with mentorship (NASEM 2019). Notably, most studies focused on a single mentor (typically a faculty mentor), thereby ignoring the broader network of mentors that provide support to emerging scientists (NASEM 2019).

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Decades of research across a variety of contexts have improved our theoretical models for understanding mentoring relationships, which can be defined as a relationship wherein a more experienced person (mentor) provides support to a less experienced person (protégé) with the goal of enhancing the latter's personal and professional development (Kram 1985; Eby *et al*. 2013). Mentors can provide several types of support, including *psychosocial support* through empathy and encouragement, *career support* through assistance on challenging tasks and advancement opportunities, and *role modeling support* through providing an example of success and communicating a pathway for achieving similar success (Eby *et al*. 2013; NASEM 2019). In college STEM contexts, receiving psychosocial and career support from a primary faculty mentor positively correlates with motivations to integrate into the sciences, such as the development of a science identity and the intention to persist in a STEM career (Hernandez *et al*. 2020). However, advancements and critiques in the mentorship literature have shown that the traditional focus on the dyadic relationship between a primary mentor and a protégé does not adequately describe the experiences or explain the impacts of mentorship support on professional development (NASEM 2019; Higgins and Kram 2001). Research has begun to shift from focusing on the quality of a single, primary mentor–protégé relationship to the web of relationships between a protégé and multiple mentors who may span social spheres (eg personal, professional) and who may be connected to one another (Higgins and Kram 2001).

Developmental mentor network theory (Higgins and Kram 2001) has advanced our understanding of mentoring through the use of egocentric social network analysis to characterize both the content of mentorship support (eg psychosocial support) and the structural characteristics that quantify social capital (ie access to information and resources) by assessing the web of connections among mentors (eg density of connections among mentors; Portes 1998; Dobrow *et al.* 2012; Borgatti *et al.* 2018). According to theory, protégés who receive psychosocial support, career support, and/or role modeling (ie support of one or more types) should experience beneficial subjective outcomes, such as developing a strong science identity, while protégés who are more deeply embedded within mentor networks (eg larger networks, higher density of connections among mentors) should experience beneficial objective outcomes, such as improved performance and persistence (Higgins and Kram 2001; Dobrow *et al.* 2012). To date, most of the research on mentor networks has focused on workplace contexts among employees (Dobrow *et al.* 2012); thus, the pattern of associations between mentor network characteristics and outcomes may vary across contexts (eg among students in college).

Research on how mentor networks influence college STEM students' academic success, career pursuit, and social integration into STEM communities is only beginning to emerge. For example, in a cross-sectional national survey, undergraduate students engaged in a biology summer research experience were asked to select one of eight pictures that best represented the connections between themselves (undergraduate protégé), a potential postbaccalaureate (postbac) research mentor, and a potential faculty research mentor (Aikens *et al.* 2016). Undergraduates who had a direct connection to a faculty mentor or had a more densely interconnected network were found to also have a stronger science identity (Aikens *et al.* 2016; Joshi *et al.* 2019), which is a powerful motivator for and indicator of social integration into STEM careers (Estrada *et al.* 2018). This novel finding indicated that, in addition to the content of mentorship support (eg psychosocial support), mentor network structures – such as having a close-knit highly interconnected network of mentors (ie a higher density of connections among mentors) – may contribute to a protégé's science identity in college STEM contexts. Likewise, in a recent longitudinal panel study to assess mentor network size, researchers asked college students at a university in the northeastern US if people in a variety of roles (eg faculty, guidance counselors, and graduate students) served as mentors in their lives, as well as follow-up questions about the overall quality of psychosocial and career support students received from their faculty mentor (Hernandez *et al.* 2020). The study found that mentor network size (eg having a variety of mentors in roles such as faculty, guidance counselors, and graduate students) and the quality of faculty support promoted short-term (ie concurrent) but not long-term (ie 6 months in the future) science identity development, over and above the strong influences of prior identity and research involvement (Hernandez *et al.* 2020). Taken together, the extant mentor network literature within college STEM contexts hints at, rather than fully describes, the web of mentoring relationships that influence students' social integration into STEM fields.

The main objective of our study was to test the effects of mentor network characteristics on short-term (ie concurrent) and long-term (ie 6 months in the future) STEM outcomes. Specifically, we assessed the influence of mentor network characteristics on the development of science identity and STEM-related graduate school applications. Furthermore, our study was conducted with a large multi-institutional sample of undergraduate women in STEM majors, all of whom had an expressed interest in Earth systems and environmental science careers (eg interests in atmospheric science, climate and Earth science, ecology, energy, natural and water resources, and oceanography).

Methods

Study design

To better understand how mentor network characteristics influence the longitudinal social integration of undergraduate women into Earth and environmental science-related STEM disciplines, we tracked a large sample of college students from nine universities in two regions of the US (Colorado/Wyoming Front Range and North/South Carolina) over a 4-year period. All participants identified as women and had an expressed interest in the Earth and environmental sciences at the time of recruitment into the study. Our analytic sample consisted of 233 undergraduate STEM majors who completed a survey in fall 2018 and continued to participate in the study (Table 1; WebPanel 1).

Data and analysis

Survey data were collected at different time points, such that Time 1 (T1) refers to spring 2018, Time 2 (T2) refers to fall 2018, and Time 3 (T3) refers to spring 2019. Students' science identity was assessed at all three time points (T1, T2, and T3) using a shortened, three-item version of the Identification with Science Scale (Chemers *et al.* 2011), whereas STEM career pursuit, operationalized as STEM graduate school applications (Yes, No), was assessed at T3 (see WebPanel 1 for details). In addition, students were asked about their involvement in research (Yes, No) and whether there were one or more persons they considered as a mentor or mentors (Yes, No) at T2. Students who indicated that they had a mentor were asked three types of egocentric social network follow-up questions (Perry *et al.* 2018): (1) name generator questions, (2) name interpreter questions, and (3) inter-relator questions (WebPanel 1). The name generator questions allowed students to name up to five mentors. The name interpreter questions asked about each mentor's career stage (eg "faculty member", "graduate student"), as well as the content of support (ie psychosocial, career, role modeling) provided by each mentor using three items from the Global Measure of Mentorship Practices and the Role Model Identification scales (Dreher and Ash 1990; Hoyt *et al.* 2012). The inter-relator questions

Table 1. Demographic and background characteristics of the sample at baseline (n = 233 undergraduate women in STEM majors)

Variable	%
Nationality	
US national	91.4
Foreign national	7.7
Racial/ethnic descent	
African	7.3
Asian	5.2
European	57.5
Latinx	6.0
Native American/Pacific Islander	1.7
Multi-racial/ethnic	12.9
Other or non-response	9.4
English first-language (Yes)	91.0
Disability status (Yes)	1.3
Parent education	
High school or less	8.6
Some college or 2-year degree	20.6
Baccalaureate degree	21.9
Masters or Doctoral degree	48.9
Major	
Agricultural sciences	3.0
Biological sciences	40.3
Engineering	23.6
Health and human sciences	0.4
Mathematics or computer science	5.6
Physical sciences	27.0
College rank at baseline	
First year	61.4
Sophomore	38.6

assessed connections among mentors by asking if the mentors collaborated on research.

We used the social network survey to assess the content of support that the protégé received from each of their mentors and then derived a network average support score across all mentors within their network (WebPanel 1). Specifically, we derived each participant's network average level of psychosocial support score (eg conveyed empathy), network average career support score (eg help developing new skills), and network average role modeling support score (eg being an inspirational example of success). Furthermore, we assessed network structural characteristics that quantified the size, connectivity within, and composition of mentorship networks. That is, we assessed network effective size (ie indicator of non-redundant/unconnected mentors in each protégé's network) and scores ranged from 0 (no mentors) to 5 (five non-redundant mentors). The density of connections among mentors was assessed for protégés with two or more mentors (ie a proportion consisting of the number of collaborative connections among mentors in each protégé's network relative to the total possible number of collaborations). Finally, we assessed the composition of mentor networks using the proportion of mentors in a protégé's network that were (i) faculty within the protégé's university, (ii) professionals outside of the protégé's university (ie network range), and (iii) graduate students or peers within the protégé's university.

We used structural equation modeling (SEM) in Mplus (v8; Muthén and Muthén 2021) to test the hypothesis that mentor network characteristics would promote short-term (ie concurrent) and long-term (ie 6 months in the future) social integration into STEM disciplines, operationalized in terms of a subjective outcome of *science identity* and an objective outcome of *having applied to a STEM-related graduate school program* (Figure 1). Importantly, we tested the impact of mentor network characteristics while statistically controlling for the potent, well-established, potentially confounding influences of prior science identity and involvement in research (Linn *et al*. 2015; Hernandez *et al*. 2020).

Results

Descriptive statistics and correlations between mentor network characteristics and the outcomes (WebTable 1) illustrated that the number of mentors identified by students ranged from none to five (42% no mentors, 13% one mentor, 21% two mentors, 12% three mentors, 6% four mentors, and 6% five mentors). Furthermore, across all students (including students without a mentor) the average effective size of mentor networks was approximately one mentor, while among students with at least one mentor (excluding students without a mentor), the average effective size was approximately two mentors (mean = 2.18, standard deviation [SD] = 1.02). Among students with two or more mentors, the average network density was relatively low (32% of potential connections among mentors were present), and among students with one or more mentors the average proportion of mentors who were either faculty within the university or professionals outside the university were 51% and 41%, respectively (WebTable 2). On average, across their mentor networks, students reported receiving very strong psychosocial support (6.23 on a 1–7 scale), as well as strong levels of career support (5.89) and role modeling support (5.75). Bivariate correlations revealed that the mentor network structural characteristics of effective size and density, as well as research involvement, were positively correlated with short-term and long-term science identity, as well as with having applied to a STEM-related graduate program. Neither the proportion of faculty mentors nor network range was related to the outcomes. Moreover, career support was correlated with short-term science identity, but neither psychosocial nor role modeling support were related to any outcomes. Given the pattern of associations, proportion of

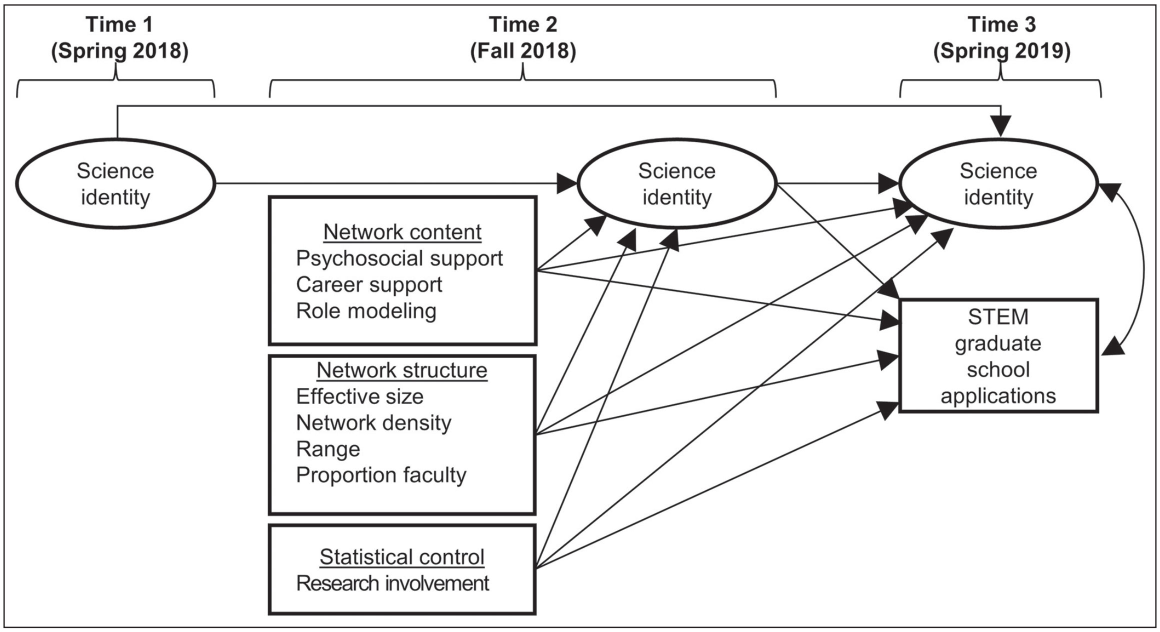

Figure 1. Conceptual model relating developmental network characteristics to short- and long-term STEM outcomes. Time 1 survey was assessed in spring 2018, Time 2 survey was assessed 6 months later (fall 2018), and Time 3 survey was assessed an additional 6 months later (spring 2019). Ovals represent latent science identity variables and rectangles represent measured variables. Network content consists of the psychosocial support, career support, and role modeling provided by mentors. Network structure consists of the effective size of the network, density of connections among mentors, range (proportion of mentors from outside the university), and proportion of mentors who were faculty. Research involvement (0 = No, 1 = Yes) was used as a statistical control.

faculty mentors, network range, psychosocial support, and role modeling support were not considered further.

Next, we used SEM to test our hypotheses that mentor network characteristics would predict short- and long-term science identity, as well as long-term applications to STEM-related graduate school programs, statistically controlling for prior science identity and research involvement. The SEM global fit statistics indicated that our model provided good fit to the data (see Notes section at the bottom of Table 2). Among students with one or more mentors, career support exhibited a small positive influence (β = 0.16) on short-term science identity development at T2. In addition, effective network size and network density exhibited small positive influences on long-term science identity development at T3 (Table 2). These findings indicate that students who received higher levels of tangible career support developed a stronger science self-identity in the short term, while those with larger effective networks and those with more connections among the mentors in their network developed stronger long-term science identity, over and above the influence of prior identity and research involvement. Furthermore, the results showed that among students with two or more mentors, those with more densely connected mentor networks were more likely to apply to a

Table 2. Structural coefficients predicting science identity and STEM graduate applications from developmental network characteristics

	Science identity^{T2}			Science identity^{T3}			STEM graduate applications^{T3}	
Source	**β**	**B (SE)**	***P***	**β**	**B (SE)**	***P***	**B (SE)**	***P***
Network eff size^{T2}	0.04	0.05 (0.06)	0.40	0.17	0.17 (0.08)	0.03	–0.04 (0.09)	0.69
Network density^{T2}	–0.14	–0.51 (0.49)	0.30	0.22	0.78 (0.31)	0.01	0.89 (0.38)	0.02
Career support^{T2}	0.16	0.20 (0.04)	<0.001	–0.17	–0.20 (0.11)	0.07	0.14 (0.16)	0.38
Research inv^{T2}	0.18	0.55 (0.22)	0.01	0.01	0.02 (0.19)	0.93	0.74 (0.21)	<0.001
Science identity^{T1}	0.60	0.70 (0.06)	<0.001	0.21	0.23 (0.07)	0.002	–	–
Science identity^{T2}	–	–	–	0.57	0.54 (0.06)	<0.001	0.15 (0.07)	0.03

Notes: Network eff size = Network effective size; Research inv = Research involvement. Assessment of "good" global data-model fit was based on root-mean-square error of approximation (RMSEA) values ≤ 0.05, comparative fit index (CFI) values ≥ 0.95, and standardized root-mean-square residual (SRMR) values ≤ 0.08 (Hu and Bentler 1999). Global model fit: $\chi^2_{(df = 55)}$ = 54.49, *P* = 0.49, CFI = 1.00, RMSEA = 0.00 (90% confidence intervals = 0.00, 0.04), SRMR = 0.03. T1 = Time 1 (spring 2018), T2 = Time 2 (fall 2018), T3 = Time 3 (spring 2019). For ease of interpretation, all predictors/control variables were centered for the analysis.

STEM-related graduate school program (Table 2). To better understand the practical impact of network density, we estimated the predicted probability of having applied to a STEM-related graduate school program for students with low or high levels of connections among the mentors in their network (WebPanel 1; Long and Freese 2001). The predicted probability of having applied to a STEM-related graduate school program increased from 8% for students with no connections among mentors in their networks (19% of the sample) to 31% for students with completely interconnected mentor networks (10% of the sample) – an increase of 23%. In comparison, the impact of network density was larger than that of previously established factors such as research experience (18% increase in predicted probability for students with versus without research experiences) or prior science identity (8% increase in the predicted probability for students with high versus low science identity, defined as two SDs above versus below the mean).

Having an interconnected network of mentors was clearly an important structural characteristic in supporting the long-term social integration of women into Earth and environmental sciences. To better understand the nature of connections among mentors, we examined the percentage of connections among mentors in different roles (faculty, postbac/peer, and professionals outside the university). Of the connections, nearly one-half (47.2%) were between faculty mentors (ie faculty–faculty connections) within the university, just over one-fourth (27.9%) were between mentors outside the university, and relatively smaller percentages were between faculty and postbac/peer mentors within the university (13.8%) or between faculty within and professionals outside the university (8.3%; other combinations of connections were negligible).

Conclusions

The results of our analysis provide novel insights into the qualities of mentorship networks that support college women's longitudinal social integration into and pursuit of Earth and environmental science careers. Most importantly, the structural characteristics of a mentorship network, which embody social capital or connections that provide access to information and resources (Portes 1998), influenced women's long-term social integration into scientific careers. Protégés with more non-redundant or unconnected mentors (ie mentor networks with larger effective sizes) developed stronger long-term science identity, while those with denser or more close-knit networks both developed stronger long-term science identity and were more likely to apply to a STEM-related graduate school program. This finding expands on prior research, which found that students in close-knit or "closed" faculty–postbac–undergraduate mentored research triads reported stronger science identity and intentions to pursue a PhD in the sciences as compared to protégés in less-connected triads (Aikens *et al*. 2016). This finding is also consistent with research on friendship networks in college STEM classrooms, which reported that having more close-knit relationships was related to taking a greater number of STEM courses (Turetsky *et al*. 2020). Furthermore, faculty appear to occupy a special role as bridges or social connectors to other mentors in undergraduate mentor networks, given that 70% of connections involved a faculty member. Taken together, we suspect that being part of a close-knit or higher density mentor network creates a "sticky web" of connections that may be needed to secure the information, resources, and benefits that keep protégés in their STEM field of choice (Turetsky *et al*. 2020). Furthermore, we suspect that faculty are key facilitators of developing close-knit mentor networks for undergraduate students.

Our results demonstrated that protégés who received higher levels of skill-related support from mentors were more likely to perceive themselves as a scientist and have a sense of belonging in their scientific community. This finding is consistent with the view that helping protégés learn the skills required by their field also reinforces their role and self-identity in their discipline (Baker and Lattuca 2010). Surprisingly, the provision of psychosocial and role modeling support was not related to science identity, but this finding does not discount the potential importance of networks that provide such support. We suspect that psychosocial support and role modeling support may influence important affective and person–environment outcomes, such as satisfaction with the learning/working environment and perceived alignment between personal and disciplinary values, respectively (Eby *et al*. 2013; Diekman *et al*. 2015).

Although this study provided novel insights, we acknowledge some caveats and limitations. First, the contents of mentorship support are nuanced and involve a diverse range of mentoring behaviors (eg psychosocial support can involve acceptance, authenticity, counseling, cultural relevance, empathy, friendship, and/or trust), which are frequently assessed with many survey questions. Our approach to assessing the content of mentorship support was limited due to concerns for participant survey fatigue. It is possible that measuring the full range of mentoring support behaviors would reveal stronger and nuanced relationships with social integration and persistence. Second, our research focused on a range of positive interactions with mentors, but research has shown that negative interactions with mentors (eg harassment or manipulative behaviors) can severely thwart protégés' progress (Limeri *et al*. 2019). Negative interactions could possibly further illuminate the impact of network characteristics on social integration and persistence. Third, our research did not assess mentor–protégé similarities that may enhance mentoring outcomes. Prior research in college STEM contexts has indicated mentor–protégé similarities (eg values similarity, gender similarity, or race/ethnicity similarity) can be associated with slightly higher levels of psychosocial and career support, particularly among students from historically underrepresented groups in STEM (Blake-Beard *et al*. 2011; Hernandez *et al*. 2017; Pedersen *et al*. 2022). Accounting for similarities within mentorship networks may reveal a more thorough understanding of the development and impacts of mentorship networks.

This research has several practical implications for programs and for individual mentors supporting women pursuing training and careers in the Earth and environmental sciences. Given the importance of mentor network structures, implementing practices that help college women develop strong, diverse, and interconnected mentor networks may be a viable method for them to gain access to the social capital essential for their science career development, as well as to reduce inequities built on societal biases and prejudice (Mitchneck *et al*. 2016). For example, both mentors and protégés can engage in activities, such as mentor network mapping and strategic networking (Pfund *et al*. 2012; Branchaw *et al*. 2020), that can help protégés to grow the size, connectedness, diversity, and strengths of their mentor networks. A faculty mentor may be particularly important for facilitating introductions with new potential collaborative mentors based on the protégé's interests or gaps in the protégé's network of support. There is also compelling evidence that mentors can improve their practices, including assessing protégé needs and connecting them to a broader network of mentors, through training and reflection (Butz *et al*. 2018). Furthermore, given the importance of skill-based career support, implementing continuous learning opportunities, such as mentored course-based and co-curricular undergraduate research experiences (Linn *et al*. 2015), may be a viable method to help college women both learn Earth and environmental science content knowledge and grow their professional science identity. Although not exhaustive, the activities above point to a larger theme of supporting women's pursuit of careers in the Earth and environmental sciences through connection and discipline-specific skill development.

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Data Availability Statement

Data and code are available in the Mountain Scholars of Colorado and Wyoming repository at https://doi.org/10.25675/10217/233920.

References

Aikens ML, Sadselia S, Watkins K, *et al*. 2016. A social capital perspective on the mentoring of undergraduate life science researchers: an empirical study of undergraduate–postgraduate–faculty triads. *CBE-Life Sci Educ* **15**: 16.

Baker VL and Lattuca LR. 2010. Developmental networks and learning: toward an interdisciplinary perspective on identity development during doctoral study. *Stud High Educ* **35**: 807–27.

Beck C, Boersma K, Tysor CS, *et al*. 2014. Diversity at 100: women and underrepresented minorities in the ESA. *Front Ecol Environ* **12**: 434–36.

Blake-Beard S, Bayne ML, Crosby FJ, *et al*. 2011. Matching by race and gender in mentoring relationships: keeping our eyes on the prize. *J Soc Issues* **67**: 622–43.

Borgatti SP, Everett MG, and Johnson JC. 2018. Analyzing social networks. Newbury Park, CA: SAGE Publications.

Branchaw JL, Butz AR, and Smith AR. 2020. Entering research: a curriculum to support undergraduate and graduate research trainees. New York, NY: WH Freeman.

Butz A, Branchaw J, Pfund C, *et al*. 2018. Promoting STEM trainee research self-efficacy: a mentor training intervention. *Understand Interv* **9**: 3730.

Chemers MM, Zurbriggen EL, Syed M, *et al*. 2011. The role of efficacy and identity in science career commitment among underrepresented minority students. *J Soc Issues* **67**: 469–91.

Diekman AB, Weisgram ES, and Belanger AL. 2015. New routes to recruiting and retaining women in STEM: policy implications of a communal goal congruity perspective. *Soc Iss Policy Rev* **9**: 52–88.

Dobrow SR, Chandler DE, Murphy WM, *et al*. 2012. A review of developmental networks: incorporating a mutuality perspective. *J Manage Stud* **38**: 210–42.

Dreher GF and Ash RA. 1990. A comparative-study of mentoring among men and women in managerial, professional, and technical positions. *J Appl Psychol* **75**: 539–46.

Eby LT, Allen TD, Hoffman BJ, *et al*. 2013. An interdisciplinary meta-analysis of the potential antecedents, correlates, and consequences of protégé perceptions of mentoring. *Psychol Bull* **139**: 441–76.

Estrada M, Hernandez PR, and Schultz PW. 2018. A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE-Life Sci Educ* **17**: 9.

Hernandez PR, Agocha VB, Carney LM, *et al*. 2020. Testing models of reciprocal relations between social influence and integration in STEM across the college years. *PLoS ONE* **15**: e0238250.

Hernandez PR, Estrada M, Woodcock A, *et al*. 2017. Protégé perceptions of high mentorship quality depend on shared values more than on demographic match. *J Exp Educ* **85**: 450–68.

Higgins MC and Kram KE. 2001. Reconceptualizing mentoring at work: a developmental network perspective. *Acad Manage Rev* **26**: 264–88.

Hoyt CL, Burnette JL, and Innella AN. 2012. I can do that: the impact of implicit theories on leadership role model effectiveness. *Pers Soc Psychol B* **38**: 257–68.

Hu L and Bentler PM. 1999. Cutoff criteria for fit indices in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Modeling* **6**: 1–55.

Joshi M, Aikens ML, and Dolan EL. 2019. Direct ties to a faculty mentor related to positive outcomes for undergraduate researchers. *BioScience* **69**: 389–97.

Kram KE. 1985. Mentoring at work: developmental relationships in organizational life. Lanham, MD: University Press of America.

Limeri LB, Asif MZ, Bridges BHT, *et al*. 2019. "Where's my mentor?!" Characterizing negative mentoring experiences in undergraduate life science research. *CBE-Life Sci Educ* **18**: 61.

Linn MC, Palmer E, Baranger A, *et al*. 2015. Undergraduate research experiences: impacts and opportunities. *Science* **347**: 1261757.

Long JS and Freese J. 2001. Regression models for categorical dependent variables using Stata. College Station, TX: Stata Press Publication.

Mitchneck B, Smith JL, and Latimer M. 2016. A recipe for change: creating a more inclusive academy. *Science* **352**: 148–49.

Muthén BO and Muthén LK. 2021. Mplus user's guide. Los Angeles, CA: Muthén & Muthén.

NASEM (National Academies of Sciences, Engineering, and Medicine). 2019. The science of effective mentorship in STEMM. Washington, DC: The National Academies Press.

NCSES (National Center for Science and Engineering Statistics). 2017. Women, minorities, and persons with disabilities in science and engineering: 2017. Arlington, VA: US National Science Foundation.

Pedersen RM, Ferguson CF, Estrada M, *et al*. 2022. Similarity and contact frequency promote mentorship quality among Hispanic undergraduates in STEM. *CBE-Life Sci Educ* **21**: 27.

Perry BL, Pescosolido BA, and Borgatti SP. 2018. Egocentric network analysis: foundations, methods, and models. Cambridge, UK: Cambridge University Press.

Pfund C, House S, Asquith P, *et al*. 2012. Mentor training for clinical and translational researchers. New York, NY: WH Freeman & Co.

Portes A. 1998. Social capital: its origins and applications in modern sociology. *Annu Rev Sociol* **24**: 1–24.

Turetsky KM, Purdie-Greenaway V, Cook JE, *et al*. 2020. A psychological intervention strengthens students' peer social networks and promotes persistence in STEM. *Sci Adv* **6**: eaba9221.

Valantine HA and Collins FS. 2015. National Institutes of Health addresses the science of diversity. *P Natl Acad Sci USA* **112**: 12240–42.

Supporting Information

Additional, web-only material may be found in the online version of this article at http://onlinelibrary.wiley.com/doi/10.1002/fee.2666/suppinfo