Family Helps Transform the STEM Pathways of Community College Women of Color STEM Majors

Melo-Jean Yap,[†]* Jasmine Foriest,[‡] Kalli Walker,[§] Sara Sanford,[‖] and Adrienne Rice[¶]

[†]Center for Teaching Excellence and Innovation, The Johns Hopkins University, Baltimore, MD 21218; [‡]Human-Centered Computing PhD Program, School of Interactive Computing, Georgia Institute of Technology, Atlanta, GA 30332; [§]Consumer Analytics, Citi, New York, NY 10013; [‖]Project Management Team, J Michael Consulting, Roswell, GA 30075; [¶]Executive Team, Sustainable Futures, Atlanta, GA 30311

ABSTRACT

A "critical access point in the STEM pipeline for Latinx students and other students of color" (Herrera *et al.*, 2018), community colleges provide a seminal breeding ground for academic pursuits (Bahr *et al.*, 2017). However, how personal networks influence STEM pathways of two-year college students remains largely unexplored. This mixed methods case study explores influence of personal networks on pursuing STEM fields via social network analysis and qualitative narratives. 36 women of color STEM majors at a two-year urban Hispanic-Serving Institution were interviewed via social network questionnaire. Participants nominated anyone who has influenced their STEM trajectory, which signifies influence to their reason for pursuing a STEM path; they also had an option to qualitatively elaborate on any nomination but this was not required. Nominations were counted towards degree centrality and categorized into social relationships. Participants nominated diverse relationship influences, with family as the most influential relationship group, followed by college faculty/staff. Qualitative narratives revealed that family influenced participants, regardless of relatives' educational attainment level at the high school or lower level. In alignment with community cultural wealth, family members provided the impetus for pursuing STEM pathways through influence on participants' (1) aspirational capital, (2) familial capital, and (3) resistant capital.

INTRODUCTION

Women of color (WOC) experience multiple challenges based on the double bind of their gender and racial/ethnic minority status in the STEM fields (Malcolm *et al.*, 1976). Deficit perspectives about WOC's low representation and retention include blaming these underrepresented students' inadequate preparation in successfully navigating academia (Koenig, 2009). However, Ong *et al.* (2011) assert that WOC "are just as likely as their White peers to intend to pursue an undergraduate STEM degree" (p. 181) but face many institutional obstacles. Because of their minoritized gender and race/ethnicity, WOC need to negotiate navigating a complex chilly climate (Hall and Sandler, 1982; Sonnert *et al.*, 2007; Griffith, 2010; Reyes, 2011) of STEM fields dominated by White men (Oh and Lewis, 2011). Malcolm and Malcolm (2011) reflect on the new challenges that the current generation of WOC scientists face: gaining support and placing the responsibility for action on institutions instead of blaming individuals and accepting biases as a natural.

Meanwhile, previous research studies have shown that faculty and peers provide substantial support and inspiration to women (Robnett, 2016) and WOC STEM students (Graham *et al.*, 2013; Perez-Felkner, 2015), including transfer students (Packard *et al.*, 2011; Starobin *et al.*, 2016). Using hierarchical generalized linear modeling

Sheela Vemu, *Monitoring Editor*

Submitted Sep 21, 2021; Revised Oct 30, 2023; Accepted Dec 12, 2023

CBE Life Sci Educ March 1, 2024 23:ar10

DOI:10.1187/cbe.21-09-0273

*Address correspondence to: Melo-Jean Yap (melo@jhu.edu).

(HGLM), Espinosa (2011) found that the best indicator for STEM persistence for WOC (in four-year institutions) lies in the frequency of their interactions with peers, not necessarily professors. Some of these interactions consist of talking about class, participating in STEM campus organizations and research programs, and having career goals to help others. It also helped if the student attended a private college and/or an institution "with a robust community of STEM students" (Espinosa, 2011, p. 209).

COMMUNITY COLLEGES AS CRITICAL ACCESS POINTS

A "critical access point in the STEM pipeline for Latinx students and other students of color" (Herrera *et al.*, 2018, p. 3), community colleges provide a seminal breeding ground for academic pursuits (Olson and Labov, 2012; Bahr *et al.*, 2017): 48% of University of California STEM bachelor's degree holders and one-fourth of all Chicanx doctorate degree holders attended community college earlier in their college careers (Community College League of California, 2015). Community colleges enroll higher percentages of underrepresented students than four-year institutions (Provasnik and Planty, 2008).

However, community college research is underrepresented even in the Community College Biology Education Research (CCBER) literature, and only 7.41% of CCBER research articles focus on equity and diversity (Schinske *et al.*, 2017) – issues that pertain to community colleges' role as a STEM critical access point for students of color. Increasing community college research that can identify access issues and disaggregate student data by layers of demographic characteristics is a step towards brainstorming how community colleges can provide solutions for broadening STEM participation (Hagedorn and Purnamasari, 2012). Wang and Wickersham (2018) urge for the use of innovative analytical approaches to further explore the STEM pathways of women through the STEM pathway from two-year to four-year institutions. Metcalf (2016) recommends using critical mixed-methods approaches in revealing richer insights about the importance of reviewing the intersections of demographic identities of underrepresented and historically excluded groups in STEM fields.

Community colleges serve as an academic pathway for students of color, yet how the social networks of two-year college students (especially WOC) influence their STEM pathway remains largely unexplored. Part of a larger study on influential networks, this mixed methods study explores the personal networks of WOC majors in the community college and how these networks have influenced them to pursue the STEM fields via social network analysis and qualitative narratives.

SOCIAL NETWORKS IN THE COMMUNITY COLLEGE

Social network analysis is a tool for studying structures of networks (Otte and Rousseau, 2002): individual actors or nodes and the links that connect them to each other (Wasserman and Faust, 1994; Watts, 2003). This case study analyzes a kind of social network called egocentric network, which focuses on the personal connections of individuals in their immediate social spheres and how existing in these social contexts may affect them (Perry *et al.*, 2018). With the ego as the focal individual or node and alters as the ones that an ego nominates, personal networks are complete networks of individuals that can be studied by looking at "the effects of the set of relationships that surround an individual, regardless of the context from which they are drawn" (McCarthy *et al.*, 2019, p. 6). Small *et al.* (2021) distinguish between sociocentric and egocentric network analysis in that sociocentric analysis "[examines] a set of actors and all their realized or potential ties between them" (p. 1) and that egocentric analysis studies "a set of actors and their relations of any type that are of interest to the researcher" (p. 1). An example of how an egocentric network can be analyzed is to compare the ego and the alter/s regarding their homophily or how similar they are to each other via attributes or other properties tied to the network (Daly, 2010). How similar one's alters are to the ego may also be informed by the ego's bonding ties and bridging ties to the alters: bonding ties can offer social support since they belong to the same social circle, whereas bridging ties can open access to new perspectives and resources since they belong to different social spheres (Coleman, 1988).

Learning more about the structure of networks can give information about how social location can facilitate gain of social capital or other beneficial resources (Bourdieu, 1985), even professionally relevant social capital among students of color navigating higher education (Rios-Aguilar and Deil-Amen, 2012). Studying the social networks of undergraduate students hold promise in learning more about how they learn in STEM classrooms (Grunspan *et al.*, 2014). Diffusion of influence and goals between highly interactive students (which can be referred to as a social contagion) has also shed some light on the potential of analyzing how social networks can be tapped to increase classroom engagement (King and Mendoza, 2021) and motivation in school environments (Burgess *et al.*, 2018). Even any cultural changes within STEM departments can be explored using social network analysis or SNA (Ngai *et al.*, 2020).

SNA studies that specifically focus on community colleges are very limited. Recent studies include using SNA to look at clustering of students' major choices (Baker, 2018), peer effects of classmates on course-taking and credit attainment (Gonzalez Canche and Rios-Aguilar, 2015), and social media connections that students use in their persistence (Rios-Aguilar, 2014b). Ruiz Alvarado (2014) performed a social network analysis of the migration pathways of Latine students transferring from community college to four-year universities, which revealed weak (formalized) connections between institutions for facilitating transfer for this student population, as well as financial challenges that hinder transferring to four-year schools. However, network studies representation of WOC STEM majors in the community college literature is even more sparse. A recent study that centers this population is Yap (2022)'s exploratory analysis of this specific subset of students and their personal networks, which showed that college faculty and staff garnered the highest number of normalized degree centrality for influence in the development of their scientific thinking.

CRITICAL SOCIAL NETWORK ANALYSIS

Network analysis involves quantitative methods, for example, linear regression models, in predicting diffusion of ideas and influence across networks using social interaction indicators, such as frequency of interaction between participants and people that they nominate (Granovetter, 1973; Marsden and Campbell, 1984). However, "the reasons, motivations, and expectations of individuals" (p. 3) in these networks can be better contextualized and understood using qualitative methods

in tandem with the quantitative methods – a mixed methods social network analysis – to create a more complex picture and understanding of these dynamic network processes (Froehlich *et al.*, 2020). How influence diffuses between nodes or agents in a network can be complex. For example, an individual may confide certain information with one nominee but not another, regardless of how frequent this individual interacts with either nominee. Inferring influence from basic relational and attributional characteristics may not be as powerful as directly asking individuals about who actually influenced them on specific things. Especially for an already understudied population such as WOC STEM majors in the community college, directly inquiring about their influences on specific topics centers their own voices. Instead of making assumptions about their influences, researchers help retain participants' agency and collect more authentic data and context about students' actual experience. This critical approach to social network analysis may also better capture the potential layered challenges and inequities that individuals face (Gonzalez Canche and Rios-Aguilar, 2015; Breiger, 2021). This reimagining of the use of sophisticated quantitative methodology such as social network analysis may contribute towards higher education research that elevates rigor, relevance, meaning, and criticality (Rios-Aguilar, 2014a).

COMMUNITY CULTURAL WEALTH (CCW)

Aside from reimagining critical approaches to quantitative methods such as social network analysis, this paper aims to explore meaningful ways of using Community Cultural Wealth (CCW) to guide this study. CCW is an antideficit theoretical framework that has the potential to complement critical social network analysis and highlight the narratives of WOC STEM majors in the community college. Born out of critical race theory in education, CCW highlights the "knowledge, skills, abilities, and contacts possessed and utilized by Communities of Color" (Yosso, 2005, p. 7) as they navigate and resist institutional structures, such as schools, which have historically excluded and oppressed them. CCW not only applies a critical approach to "multiple intersectional, nonconflatable axes of power inequality" (Colina Neri *et al.*, 2021) but also elevate agency towards resisting micro- and macromanifestations of oppression, such as racism.

Yosso (2005) conceptualized at least six forms of dynamic processes of cultural capital that are nurtured within communities of color: (1) aspirational, (2) navigational, (3) social, (4) linguistic, (5) familial, and (6) resistant. In aspirational capital, an individual retains hope for and overcomes challenges towards a better future. Meanwhile, in navigational capital, an individual adapts to skills that can enable them to navigate institutions and structures outside of her community. Next, in social capital, interactions with peers and networks can provide access to community resources. Then, in linguistic capital, speaking, thinking, and knowing more than one language enhances the intellectual and social development of one's communication style. In addition, in familial capital, family and community history and traditions cultivate a localized cultural knowledge as experienced in close kinship. Finally, in resistant capital, an individual has become equipped with the skill and knowledge on how to resist and challenge inequality. These forms of cultural capital are meant to capture dynamic processes and they intertwine with each other (Colina Neri *et al.*, 2021).

As more and more higher education researchers engage with the CCW framework, a systematic review of the STEM education literature showed that empirical studies that use this theoretical lens often focus on engineering settings, four-year institutions, and qualitative interview methods (Denton *et al.*, 2020). For example, Samuelson and Litzler (2016) highlighted the forms of CCW capital in their interviews with Black and Latine engineering students across different universities. Meanwhile, Rincon and Rodriguez (2021) applied CCW as they studied Latine students from various STEM disciplines using qualitative interviews. In combination with other theories such as Transfer Student Capital – which refers to knowledge such as social and cultural capital that can aid in transferring to a four-year institution (Laanan *et al.*, 2011), CCW has been starting to get adopted by STEM education researchers in two-year colleges as well (Mobley and Brawner, 2019), yet often focused on qualitative approaches.

There have been few or no empirical studies on WOC STEM students in the community college, especially at Minority-Serving Institutions (MSIs), that employ both quantitative and qualitative methods and are contextualized using CCW. For the qualitative narratives provided optionally by participants, this study uses the CCW framework to elucidate any various forms of capital at play as WOC STEM majors in a two-year Hispanic-Serving Institution (HSI) name who have influenced them to pursue STEM fields from their existing social networks.

RESEARCH QUESTIONS

This research question guides this study:

> *Which social relationships shape or influence the STEM career trajectory of* WOC *STEM majors in a two-year HSI?*

A sub-research question is based on the qualitative data; this subquestion seems broad due to its qualitative and emergent approach to the narratives from participants: How do these social relationships shape or influence participants' STEM career trajectory?

METHODS

Researcher Positionality

The research team comes from diverse personal (racial/ethnic, gender, and class identities) and professional (academic training and work experience) backgrounds that shape and inform their positionality as researchers. Melo-Jean Yap has navigated the community college through the lens of multiple identities over the years: student, staff, professor, and researcher. She is a gender-expansive, woman of color, a 1.5 generation immigrant – someone who immigrated at a young age, sharing experiences with both first- and second-generation immigrants (Park, 1999) – and the first in her working-class family to attend school in the United States. Next, Jasmine Foriest is a Black woman, first-generation college-going student, and public health disparities tech scholar. She views research as an opportunity to tell stories and facilitate epistemological justice. Meanwhile, Kalli Walker is a woman of color in the field of fraud analytics with expertise in strategic analysis and insightful reporting. Her personal experience as a Black woman raised in the lower middle-class has affected her ability to pay for college. She has had to juggle the responsibilities of being a full-time student while balancing a

TABLE 1. Aggregate demographics of study participants ($n = 36$)

Demographics	Number	Percentage
Race or ethnicity		
Black/African American/African/Afro-Carribean	6	16.67%
Latina	19	52.78%
Asian/Pacific Islander	6	16.67%
Multiracial/Multicultural	5	13.89%
Field of Study		
Biological Sciences	15	41.67%
Chemistry/Biochemistry	9	25.00%
Engineering	6	16.67%
Physics/Astronomy	2	5.56%
Computer Science	1	2.78%
Nutritional Science	3	8.33%
Age		
Average	24.08 y	-
Range	19–37 y	-
Attendance at Site		
Average	2.61 y	-
Range	0.5–6 y	-
Miscellaneous		
First-Generation (FG) college students	22	62.11%
Second-degree/Career transition students	9	25%
Financial aid recipients	32	88.89%

full-time job, which has informed her positionality regarding this research topic. In addition, Sara Sanford is a White woman trained in Psychology, Neuroscience, and Evaluation methods, particularly clinic research, public health, and program and project management. The experiences that have informed her positionality regarding this research topic include her time as a former STEM graduate student and a clinical research staff on projects on underserved populations. Finally, Adrienne Rice is a Southern Black American woman with training in community/labor development, research, education counseling, environmental climate justice, and racial equity. She is also a first-generation college graduate who attended a community college for one semester.

As a collective of scholars, we aim to share this work not merely for the purpose of advancing scholarship in relevant fields, but also to build community with others who find any aspect of this article fascinating and/or reflective of their goals, lived experiences, or intellectual interests. We encourage any interested individuals to reach out to us as well as check out Melo-Jean Yap's public GitHub repository that STEM education researchers can access as a resource for how data visualizations were created for this article and other writings related to the larger research grant (*NSF DUE # 1937777: Influential Networks for Women of Color in STEM Community College Pathways*) this study comes from. This is the link to the GitHub page: https://github.com/1melomelo/Women-of-Color-STEM-influential-networks.

Overview of Methods

Part of a larger study on the influential networks of WOC STEM majors in the community college, this case study is a mixed methods critical social network analysis. The larger study designed and utilized a social network questionnaire, an instrument with ten name-generator questions (one of which is the focus of this study) on influences to various aspects of participants' scientific thinking and college navigation, as well as an optional component in which participants can share stories regarding any of their nominations from the name-generation portion; in-depth semi-structured interviews were also conducted after the network questionnaire in the larger study. This case study focuses on the influence on participants' interest in pursuing STEM fields.

Although both quantitative and qualitative data were derived from the same questionnaire and collected at the same time, this case study uses an explanatory mixed-methods approach, in which network analysis statistics (particularly, degree centrality) was analyzed first and then optional qualitative narratives were analyzed to explain upon the quantitative results (Cresswell and Cresswell, 2017) through the theoretical lens of a critical social theory, CCW (Yosso, 2005).

This study was approved by M.-J.Y.'s former institution's Internal Review Board (IRB) on February 1 2016 (case number is IRB# 16-000078 and expired on January 31 2019). Then, M.-J.Y. received exemption in her institution's IRB (Protocol # HS-2019-0175) at the time when this grant was active.

Site and Recruitment

Marvel Community College (MCC) is a pseudonymized two-year HSI in an urban metropolitan city in Southern California. It serves approximately 20,000 students: at least 75% students of color, 60% women, 60% financial aid recipients, and 45% first-generation college-going students.

Thirty-six WOC STEM majors were recruited via snowball sampling (Babbie, 2016), flyer distribution, and in-person recruitment, based on the affirmative answers to the following eligibility questions: (1) Are you currently a student at the site

(MCC)? (2) Are you majoring in STEM (Science, Technology, Engineering, and Mathematics)? (3) Do you identify as a woman of color, for example, Latina, African American, Native American, Asian Pacific Islander, or multicultural? (4) Will you pursue a STEM major upon transferring to a four-year institution? Participation occurred between January 2017 until June 2018.

Participants in the Sample

All 36 WOC STEM major participants were current students at MCC at the time of the study. Table 1 shows the demographic information of participants. Black/Indigenous/Women of Color (BIWOC) were represented in this way: 52.78% Latina, 16.67% Black/African American/African/Afro-Caribbean, 16.67% Asian Pacific Islander, and 13.89% Multicultural. Averaging at 24.08 y, their ages ranged from 19 to 37 y old. Thirty-two (88.89%) self-reported as financial aid recipients, including the state's tuition fee waiver initiative. Ranging between a semester and 6 y, participants have spent an average of 2.61 y in the community college at the time of data collection with each specific participant.

Multiple STEM fields were also represented in the sample: 41.67% Biology, 25% Chemistry/Biochemistry, 5.56% Physics, 16.67% Engineering, 8.33% Nutritional Sciences, and 2.78% Computer Science. The Nutritional Sciences major was included since students in that major were taking the same introductory STEM courses as the other STEM majors, plus these students were interested in aspects of nutritional research in the future.

Twenty-two (61.11%) participants were first-time college students, while nine (25%) have previously or are concurrently attending a four-year college. Six of these nine participants (16.67%) who have previously attended a four-year college matriculated at a four-year institution after high school, attended it for a year or less, then withdrew after undergoing traumatic personal and academic experiences or financial struggles. Five (13.89%) participants finished a non-STEM college degree, for example, Fashion Merchandising, Film Special Effects, and Sociology, and pivoted to a new career in the STEM fields by enrolling in the community college.

SNA Questionnaire: Influence to pursuing STEM fields

In the larger study, M.-J.Y. created a social network questionnaire to collect data on the influences to participants' scientific thinking and college navigation. This paper only focuses on who have influenced the participants to pursue the STEM fields. For this focus, participants were asked "Can you think of individuals who shaped or influenced your STEM career trajectory?" Called a name generator network survey, this question elicited nominations, if any, to influences for this aspect of their experience so far. There were no bounds for the number of nominations as to prevent "[producing] error if the numeric limit is relatively small" (Perry *et al.*, 2018, p. 88): participants can name none or as many as applicable to center their perspective as much as possible. After a participant named all the nominations, the list was clarified and confirmed if they were finished nominating. There were also no restrictions on how long they have known the ones they nominated and on whether they have any current interactions.

After influences were nominated, participants then provided demographic characteristics about each nominee, such as social relationship to a participant, frequency of interactions (daily, weekly, monthly, few times a year, yearly, not anymore, and never met – which applied for public figures such as prominent scientists, etc.). Berkman and Glass (2000) have shown that two actors in a network having direct contact is not necessary for influence to happen, so it could be possible to nominate someone that a participant has never met, such as a famous scientist. Other demographic attributes provided were perceptions of their nominations' gender, race/ethnicity, age, major (if student), financial aid recipient (if student), and enrollment status at MCC. Since age were perceived estimates by participants, this variable was turned into ordinal categories according to these groupings: (1) under 18 y old, (2) 18–24 y old, (3) 25–39 y old, (4) 40–54 y old, and (5) 55+ y old.

For this case study, the social relationship of nominations to the participants were then categorized nomination by nomination, and then placed in more fine-tuned categories in which seven categorical relationships emerged: (1) Family, (2) College Faculty and Staff, (3) Friends (met outside of MCC), (4) K–12 Educators, (5) Public Figures (real or fictional characters that exist in the popular culture imagination), (6) Local Community Members (those who do not fall in any of the above categories, such as work supervisor outside the campus, church pastor, etc.), and (7) Religious Figures (could be entities from religious or spiritual texts). After the seven relationship categories emerged, an esteemed colleague outside of the research team also categorized the social relationships in a subsample using the seven categories and determined a 98% inter-rater reliability (IRR) with the team.

Although not required, participants also had an option to share any details or narratives about their nominations. One hundred percent of participants (who had a nomination) shared at least one story about any of the ones that they nominated. However, if a participant nominated the same individual in different questions of the SNA questionnaire in the larger study, there was a tendency for these participants to share stories in a cumulative manner that usually encompasses multiple questions in the whole SNA questionnaire (not just for the specific question focus of this paper). Only the optional stories that relate to influencing participants to pursue the STEM fields were considered for further analysis.

Egocentric Social Network Analysis

"A participant's personal or egocentric network was created based on the nominations. As such, this type of network focuses on a specific participant or ego and her social ties (the ones she nominated) called alters (Newman, 2003). Shining light on the characteristics of the alters may reflect a participant (ego's) access to resources and information (Lin *et al.*, 1981). Diffusion of ideas and influence can also be explored and inferred from such analyses.

Using the relational (social ties between ego and alters) and attributional (demographic characteristics) data, networks were analyzed for degree centrality or the total number of ties that a node or ego has (Borgatti *et al.*, 2018). Since this is an egocentric study (that only obtained nominations from the participants), all of the nominations would be considered as out-degree centralities; however, we have no information about the nominations of the alters, unless they were also egos—which applied to other components of the larger study not to this specific case study. Hence, the ego networks were undirected and degree centrality was the network measure used. For example,

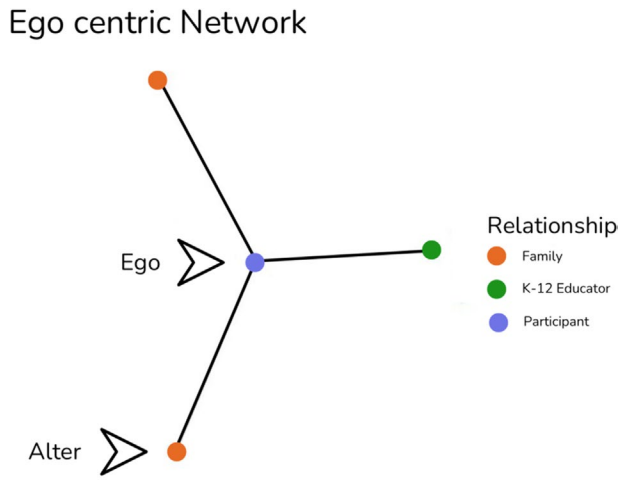

FIGURE 1. Egocentric network. This shows an egocentric network of Kamala, a Latina participant studying Biology. Kamala is the ego (indicated by the arrow and label), and the alters (indicated by the arrow and label) are those she nominated as influences. The colors of the alters signify their relationship to the participant. Kamala nominated two family members (coded in red) and a K–12 educator (coded in green).

the participant Kamala has a degree centrality of three since she nominated three influences; meanwhile, her ego network has a size of three from the three total nominations as network size refers to the number of distinct alters (Perry *et al.*, 2018).

The distribution of these degree centralities across specific relationship categories were then examined. Degree centralities were normalized at the relationship category level per participant: divide the number of nominations in a participant's relationship category by the participant's degree centrality or total number of nominations in all relationship categories. Therefore,

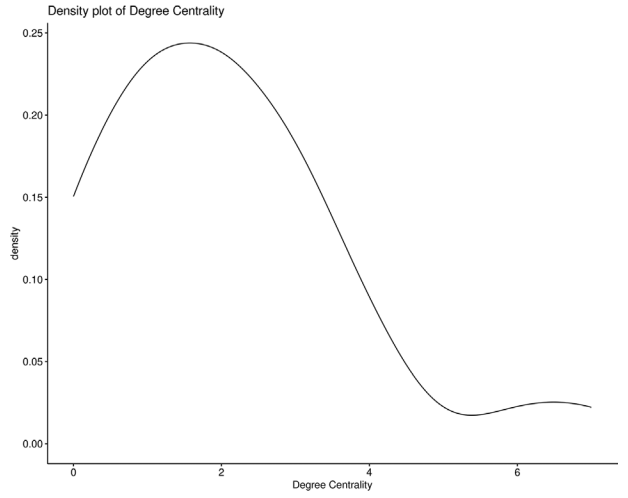

FIGURE 2. Density Plot of Degree Centrality. This plots the distribution of how many participants nominated as influences. The x-axis corresponds to the degree centrality or the total number of nominations of a participant and the y-axis represents the proportion of participants with the corresponding degree centrality.

the normalization values ranged from 0 (no nominations) to 1 (100% of nominations) per participant. Figure 1 visualizes Kamala's ego network, in which two of her nominations were family members and one was a K–12 educator; hence, the normalized value for her Family alters is 2/3 and 1/3 for her K–12 Educator alters. Figure 2 reflects a density plot of degree centralities, which is the distribution of how many influences the participants nominated.

Qualitative Narratives

The research team employed an interpretive research design, centering participants' meaning-making processes (Patton, 2015) regarding how the experiences and perspectives that led them to choose to pursue a STEM pathway. In addition to the optional qualitative narratives that participants shared during the social network questionnaire, as part of the larger study, almost 70% of participants agreed to undergo audio-recorded in-depth semi-structured interviews that lasted approximately 45 to 90 min. These qualitative deep dives allowed a space to further explore and reveal the essential nature of the complex phenomenon of pursuing STEM careers (Kvale and Brinkmann, 2009). These qualitative narratives also focus on the emic or insider's perspective of the student's process, understanding, and meaning in this complex learning environment that is the community college – a space with a specific local culture (Hudelson, 1994) in which she is experienced and thoroughly encultured in (Spradley, 1979).

For the interviews in the larger study, Seidman's (2019) three-part interview series format was used: Part I on focused life history, Part II on details of experience, and Part III on reflections on meaning. Here are some relevant sample questions to learn more about who influenced the participants to pursue STEM fields from each part of Seidman's (2019) interview series: "How did you become interested in science or research?" (Part I); "Describe your previous experiences as a student in STEM classrooms" (Part II); and "What or who has helped you the most in staying in your STEM major?" (Part III). Open-ended questions were primarily asked to evoke rich data or thick description (Geertz, 1973) about what participants find relevant and significant.

This paper used qualitative narratives to complement and contextualize main findings from the social network's quantitative results. Documenting analytic reflections about the data (Saldana, 2021), analytic memos were also reviewed to gain additional contextual information for data triangulation.

Qualitative Coding Analysis

For the optional qualitative narratives shared during the social network questionnaire, those were transcribed as close to verbatim as possible by M.-J. Y. and then compiled according to the relationship of the nomination to the participant.

Meanwhile, audio recordings of the interviews were sent to a professional transcription service via uploading on TranscribeMe.com; transcriptions were then made available. After downloading the interview transcripts, they were then uploaded to a cloud-based computer-assisted qualitative data analysis software (CAQDAS) called Dedoose. In vivo coding was used to highlight specific portions of the transcript and assigned to nodes of code, which is "a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or

evocative attribute for a portion of language-based or visual data" (Saldana, 2021, p. 5). A preliminary parent code list was created based on the questions in Seidman's (2019) three-part interview series.

As part of the explanatory design approach, the qualitative findings were used to describe the patterns demonstrated by the quantitative network findings and contextualize these results. The most prominent relationship category of nominations was selected and used as a filter through the optional qualitative narratives available. Afterward, Yosso (2005)'s community capital wealth was then used to see if any of the filtered narratives apply to any of its dimensions of capital: (1) aspirational, (2) navigational, (3) social, (4) linguistic, (5) familial, and (6) resistant.

Finally, the qualitative narratives that apply to any dimension of Yosso (2005)'s community capital wealth were turned into analytical sandwiched vignettes, in which vignettes or snippets of events, behaviors, or quoted speech from participant data are "sandwiched" by the researchers' interpretation of what the vignette illustrates. Unlike its historical use in social science research as a fictionalized scenario that is presented to participants to evoke a response during data collection (Barter and Renold, 2000), the vignette form was used in this case study as an interpretive framework for the qualitative narratives. Similar to a sandwich in which the excerpt data or vignette is the patty in the middle, the sandwiched vignette starts with an analytic point that contains the main point of the excerpt, followed by orienting information that bridges the analytic point and excerpt or vignette and introduces the excerpt and puts into context what is happening, then the excerpt from the data (like a sandwich patty), and an analytic commentary or interpretation of the excerpt. The sandwiched vignettes were used to highlight any dimension of CCW that applies to the quantitative findings.

Study Limitations

This study only provides a snapshot of a year when these particular students declared their STEM major and intended major upon transferring. They may or may not have persisted in their STEM major either as they continue to navigate the community college or transfer to a four-year institution. Validity threat issues were mitigated by creating reflective memos before data collection and after data analysis from field notes, which include jottings (active participant observation), running record (or raw notes in real time), etc. (Emerson *et al.*, 2011), in order to curb down potential biases and assumptions on M.-J.Y's insider-outsider status as a staff member at MCC at the time of data collection. She was an insider in that she had unique access to students and staff, but she was also an outsider since she was not a matriculating student there herself. She also performed member-checking with participants to make sure that the interpretations of interviews and field notes are accurate. Employing a mixed methods approach also aided in data triangulation between the quantitative network findings and the qualitative narratives about the nominees.

RESULTS

Participants nominated diverse relationship influences to their pursuit of STEM fields, with 44.44% of them nominating family members which makes it the most influential relationship group. 33.33% of participants also nominated college faculty and staff; 25.00% named K–12 educators; 13.89% nominated local community members; 11.11% named friends; 8.33% nominated public figures; 2.78% named religious figures; and 16.67% nominated no one as influences. Of the 73 total nominations, 30.14% (20) were family members, 23.29% (17) were college faculty/staff, 15.07% (11) were friends, 13.70% (10) were K–12 educators, 8.22% (6) were local community members, 8.22% (6) were public figures, and 1.37% (1) was a religious figure. While the vast majority of the nominations were positive influences, there were two nominations (2.74%) that were negative – both were K–12 educators who explicitly told two participants (separately) that they would not go far in life and tried to block opportunities for them to advance their education.

Figure 3 shows the distribution of the nominations in each relationship category (x-axis) by normalizing the nominations per participant (on the y-axis), making each participant her own control. It demonstrates the diversity of the social relationships that influence participants in their STEM career pathways and the majority of these influences distributed among family and college/faculty staff.

Network Properties

The sum of all degree centralities for all participants was 73, which means that is how many total nominations were named. However, six of 36 participants did not nominate anyone, so they did not have any alters.

For the degree centralities of all ego networks, the range was 0–7 (nominations), the average was 2.03 (nominations), the median was two (nominations), and the mode was one (nomination). Meanwhile, the SD was 1.63 and the variance was 2.66. The Shapiro-Wilk normality test was performed and confirmed that the distribution of degree centrality in all ego networks did not follow a normal distribution (p value was 0.0023, implying that the distribution of the data was significantly different from a normal distribution). Hence, the 95% confidence interval was not calculated since a normal distribution was not assumed.

Alter Attributes

For the perceived gender identity of the alters, 46.58% (34) were women, 52.05% (38) were men, and 1.3699% (1) was not applicable (as the nomination was a school and not an individual). For the racial/ethnic distribution of the alters, 36.99% (27) were Latine, 27.40% (20) were Asian, 23.29% (17) were White, 8.22% (six) were Black/African American, 2.74% (two) were multiracial/multicultural, 1.37% (one) was not applicable. As the participants are 100% WOC and family as the highest percentage of nominations, it makes sense that the race/ethnicity of the alters would also be predominantly people of color (approximately 76%). The White and men alters may come mostly from the faculty nominations, as they are a dominant and overrepresented gender identity and racial/ethnic group in higher education (especially STEM departments), regardless of whether they reflect the demographics of the student population or not.

Meanwhile, these were the perceived age groups: The age group categories were: under 18-y old was 1.37% (1); 18–24 y old were 10.96% (8); 25–39 y old were 30.17% (22); 40–54 y old were 27.40% (20), and 55+ y old were 28.77% (21). The mean age group was 3.72 (close to the range of 40–54 y old),

FIGURE 3. Proportion of Relationship Nomination Per Participant. This is a heatmap of influences normalized by relationship per participant. The y-axis shows each participant (pseudonym) and the x-axis shows the relationship of an influence to the participant (the relationships are family, college faculty/staff, friends, K–12 educators, local community members, public figures, and religious figures). Ranging between 0 (snow white) to 1 (dark purple), color intensity was determined by calculating the normalized values of nomination for each category by participant. For example, Kamala nominated three influences total – two of which are family members and one is a K–12 educator; hence, the color intensity of her row is informed by 2/3 value under Family and 1/3 value under K–12 Educator.

the median was 4.00, the mode was 3.00, the SD was 1.05, and the variance was 1.10.

Finally, these were the frequencies of interaction with the alters: 30.14% (22) were daily, 12.33% (9) were weekly, 15.07% (11) were monthly, 12.33% (nine) were few times a year, 2.74% (two) were yearly, 17.81% (13) were not anymore (one was the school which the participant used to frequent), 9.59% (7) were never met. Over half of alters interacted with participants on a regular basis (either daily, weekly, and monthly), which probably reflects the strength of ties either as family members interacting regularly or professors teaching them throughout the semester/s.

Qualitative Narratives

Qualitative narratives revealed how family influenced participants, regardless of the relatives' educational attainment level at the high school or lower level. Even though their parents and elderly family members may not have had the chance to go to college, these family members still influenced them and shaped their STEM career trajectory. Of those who shared stories about their family nominations, three themes emerged that aligned with the aspirational, familial, and resistant capital dimensions of community capital wealth: (1) aspirational capital from relatives (especially mothers) who encouraged participants to enjoy learning science and pursuing it; (2) familial capital from older siblings who cultivated their knowledge and passed on academic resources; and (3) resistant capital from witnessing their loves ones undergo medical racism and negligence. While these three themes have been primarily associated with specific CCW capitals, it does not mean that the themes do not apply to multiple forms of capital as these are dynamic processes that cross over to each other (Colina Neri *et al.*, 2021).

Aspirational Capital: Relatives Who Encourage Curiosity

Participants shared that family members have always encouraged them to explore and pursue their curiosity about learning, especially about science and mathematics. For example, 24-y-old Latina Biology major, Kamala, nominated her parents because they always "helped with encouraging and choosing [her] STEM major" and that it was "worth it" to pursue Kamala's dream to study Biology. Kamala continued, "They remind me that I like science and that I'm good at it, since I always discourage myself." Kamala's parents not only cheered her on – they also reminded Kamala of who she is: a person who enjoys and excels in science, a person who can pursue her passion and can succeed.

Meanwhile, 21-y-old Black Chemistry major, Okoye, nominated her father as a tremendous influence to pursue the STEM fields. Her father is an educator who has always told Okoye to "dream big" since she was a child:

> When I was in middle school, I had a big idea for a science project on cancer, so my dad suggested that I call a cancer center to request genomes of different cat species.

While Okoye took the initiative to start this ambitious science project, her father not only encouraged her but also gave her a suggestion to expand on her research even further. Okoye had a few more ambitious science project ideas in her youth, and her father supported her in pursuing all of them. Over the years, Okoye's father has cultivated her aspirational capital in becoming and being a scientist.

Familial Capital: Older Siblings as Knowledge Brokers

Participants also nominated older siblings as influential in shaping their STEM career trajectory. Unlike the parent or grandparent nominations, older siblings usually navigated schools first, including college (and even pursued STEM majors as well). For example, 24-y-old Cell and Molecular Biology major Elsa indicated that her older brother paved the way for her STEM pathway. At the time of the interview, her brother was a graduate student in Biology. Elsa shared that she "follows in his footsteps" as she embarks on this academic journey. Similarly, 24-y-old Latina Civil Engineering major Elektra also cited a similar sentiment about her own older brother who was a Mechanical Engineering major at a four-year university at the time of the interview. These older siblings were more like peers to the participants, and for our first-generation college-going participants, their parents still did not have first-hand knowledge of going to college and doing so successfully. Therefore, both they and their siblings were still considered as first-generation college-going students, but the younger sibling benefitted from their older sibling going to college first. This familial tie was the source of capital for the knowledge of pursuing a STEM career pathway.

Aside from brokering academic wisdom from having gone to school first, siblings have also interacted with their younger sisters (the participants) in ways that nurtured their intellectual creativity and curiosity all their lives. For example, 25-y-old Latina Biology major Nico nominated her older sister (who was in medical school) as her biggest motivator in pursuing her STEM dreams. Ever since they were young, they have always "fed off each other's love for science" and they both pursue STEM careers. Nico reminisced a childhood memory when she was 8 y old and her sister was 10 y old: her sister woke up in the middle of the night because her stomach was making weird sounds. Her sister then said, "I hate my large intestines." They continued talking about it by getting into science talk, even bringing up that there were probably parasites in her intestines. These two sisters would have these talks in which they incorporate science talk in day-to-day life since childhood. Hence, their familial capital facilitated not just information about schooling, but intellectual and creative development as well.

Resistant Capital: Witnessing Relatives Undergo Medical Issues and Injustice

Participants' experience accompanying parents and grandparents to medical appointments for various serious medical conditions (along with their positive or negative interactions with medical professionals) led to a deep curiosity about biomedicine. Participants also expressed feeling helpful at these visits since they have more education, science knowledge, and knowledge of speaking and reading English (for first- and second-generation immigrants). For example, 19-y-old Latina Biology major Frankie acknowledged an even more personal origin to her passion for biomedicine: caring for her grandmother when she was in high school. Frankie was an energetic interviewee with a jovial demeanor; however, when she talked about her grandmother's demise, Frankie's tone shifted to more a more serious one, even sprinkled with some sadness and anger at the medical professionals that failed her loved one:

> When my grandma got sick, that's when I was in the hospital a lot … I was just like, "I like being in hospitals." For some reason, I liked walking around. I liked looking at the machines. I liked hearing the nurses talk, and I was like, "That sounds cool. Maybe I can be in this," right? And there was an incident where my grandma – she had a blow to her head. They had noticed that in her autopsy. And that was before she passed away. And they were like – we filed a lawsuit because we had figured out that one of the nurses weren't – they weren't treating her well. And so, we were under the assumption that maybe that was a purposeful thing, or even if it wasn't, maybe the nurses had accidentally done something, didn't say anything about it, and that caused it to happen. So, we were upset and we filed a lawsuit on it. Lawsuit didn't go anywhere, and so that was down the gutter. But in my head to this stay, I'm still like, no, that was not – that could've been avoided.

The hospital environment already piqued Frankie's curiosity about the high-tech medical devices and medicine talk. She also shared that she became an English translator and broker of medical information between the medical professionals and her family. However, Frankie's accounts of the alleged medical negligence by the medical staff fueled a fire in her. She saw how "badly [her] grandma got treated at the hospital when she was staying there. Her grandma fell and got a hip injury in addition to heart problems, diabetes, and kidney issues. Frankie was angry at the nurse for dropping a vase. Frankie wanted to show how it is supposed to be done – taking care of people in the hospital – which is why she wanted to enter the field, initially as a nurse, "especially when people are depending on you."

Yet, even before this, Frankie has already been highly motivated as she aspired to honor her parents' sacrifices for their family:

> I give my parents a lot of props for growing me, nurturing me because to make it out of Mexico and then not even have any complete elementary education, and then coming here and giving me all that I have, and the opportunities that I have, that's amazing for them to do. So, I really appreciate that, and seeing that, I know I can't fail, because I already have – not in a disrespectful manner, but the upper hand from what they had. So, it's like, from what I have, I can't fail because they made so much from so little. I already have a lot more, so I can't not do that. That's not an option.

Immigrated to a predominantly Black and Brown neighborhood in a metropolitan urban area in Southern California, Frankie's parents have ignited in her a profound aspirational capital that is unique to their family history. In spite of not even finishing elementary school, her parents provided this valuable family legacy that Frankie can access anytime she needs a reminder of how far her family has come and how far she can also go in her STEM pathway and life in general. Frankie's compassion for her grandmother also cultivated in her a deep desire to serve others well and fight for their human rights for quality healthcare.

Honorable Mention: College Faculty and Staff

College faculty and staff garnered the second highest degree centrality in influencing students to pursue STEM fields. A representative narrative data from Dallas, a 20-y-old Latina and White Biochemistry major, fondly nominated her Chemistry professor, Dr. Segal, as an influence. When she was in high school, she started taking community college classes to earn credits and happened to take Dr. Segal's class. Dallas felt compelled to study Chemistry further but was unsure, but thanks to Dr. Segal for encouraging her to pursue it:

> We sat down to go over the process [of how to pursue a Biochemistry career]. He made it seem possible.

Dr. Segal provided both encouragement and advising that quelled Dallas' doubts about embarking on a STEM pathway. This finding on supportive faculty aligns with Yap (2022)'s recent study that demonstrated ways of how faculty have influenced the scientific thinking development of WOC STEM majors in the community college.

DISCUSSION

In this study, the influence of family has developed the CCW of WOC STEM majors in a two-year HSI in a metropolitan urban city in Southern California.

The prominence of family and college faculty and staff as the top two influences may suggest that participants accessed both their personal networks' bonding and bridging ties as critical motivators in their STEM career choice. In alignment with Coleman (1988)'s definitions, family is within a participant's personal sphere that can provide emotional support while college faculty belong outside a participant's social group but can relay novel information about STEM knowledge and opportunities. Family having known the participants for practically all their lives demonstrates a strong bond and insider knowledge of participants' motivation systems and personalities, as well easy sharing of information; if participants are close to these relatives, then it can be inferred that they have access to a shared body of information (including STEM career-related information). Family being the top influences also suggests that their familiarity with participants created strong ties that can inspire or transform participants' decisions to pursue a STEM pathway. Meanwhile, faculty can provide a pathway for new information about STEM careers that participants may not have prior access. This especially makes sense if the participant is a first-generation college student (or with her sibling, the first generation in their family to attend college).

However, the qualitative narratives present a complex picture of family as bonding ties: they provide more than just emotional support – they enrich students' STEM career pathways through multiple dimensions of community capital wealth. Family members provided the impetus for profound personal influence on participants by providing: (1) sustained encouragement that feeds their aspirational capital over the years (similar to Coleman's bonding ties definition), (2) familial capital that fosters resource sharing and intellectual stimulation between siblings, and (3) fortification of resistant capital from witnessing ill family members struggle with navigating oppressive medical institutions.

Family heavily influenced the STEM career trajectory of participants, regardless of how much formal schooling the relatives have had. Even though their parents and elderly family members may not have had the chance to go to college, these family members still influenced them and shaped their STEM career trajectory in ways beyond providing mere emotional support. Previously, Zuckerman and Lo (2021) has shown that cultural capital from family of first-generation transfer students may not provide as much specific resources or guidance for navigating the university, as this kind of knowledge is not valued in higher education. However, having an older sibling who is also pursuing a STEM pathway has been invaluable to our first-generation participants, not only in introducing them to specific knowledge about navigating this path but also cultivating critical thinking throughout their lifetime. While other family members who did not go to college may have limited or no specific information about being a STEM major, the aspirational and resistant capital that they nurtured within the participants deeply motivated these women and may contribute to their persistence, especially with resisting a system that has historically excluded them in higher education.

Recent studies have shown that students of color (particularly Latine) access their CCW in cultivating a culturally sustainable identity as STEM students (Rincon and Rodriguez, 2021). While these studies focused on Latine students of all gender identities and occurred in four-year Predominantly White Institutions, they still show similar findings of highlighting CCW, in terms of family encouraging and nurturing the budding scientists since they were young (Rincón *et al.*, 2020b), siblings modeling for younger siblings in their academic paths (Aguirre *et al.*, 2020), participants being driven by helping (Samuelson and Litzler, 2016) family members with their health issues (Mein *et al.*, 2020) and fight against an oppressive system (Rincón *et al.*, 2020a).

The impact of family is transformational in students' STEM career pathways. Since first-generation students may be heavily connected to their families and communities, perhaps community college faculty, staff, and administrators can find ways to include not just potential students but also whole families in their outreach efforts. At MCC, there have been outreach efforts (initiated by either administrators, faculty, or STEM campus organizations) to bring K–12 students into the campus to expose youth from the local community to a college environment, including engaging these pupils in STEM lab activities. These are examples of great initiatives, but we can extend these efforts into engaging everyone in the family: there is an opportunity to engage families in science together, so that they can do science together and talk about their shared scientific experience even after the outreach events. Instead of isolating students from their relatives who may not have attended or graduated from college, campus personnel should encourage strengthening these existing ties and create family-inclusive programming.

ACKNOWLEDGMENTS

This research was supported by the National Science Foundation (DUE-1937777). The UCLA Institute of American Cultures (IAC)—particularly the UCLA American Indian Studies Center, UCLA Bunche Center for African American Studies, and UCLA Chicano Studies Research Center—provided a generous grant towards participation incentives. Any opinions, findings, and conclusions or recommendations expressed in this material are our own and do not necessarily reflect the views of the National Science Foundation and the UCLA IAC.

REFERENCES

Aguirre, H. C. C., Gonzales, E., & Banda, R. M. (2020). Latina college students' experiences in STEM at Hispanic-Serving Institutions: Framed within Latino critical race theory. *International Journal of Qualitative Studies in Education*, *33*(8), 810–823. https://doi.org/10.1080/09518398.2020.1751894

Babbie, E. R. (2016). *The practice of social research*. Boston, MA: Cengage Learning.

Bahr, P. R., Jackson, G., McNaughtan, J., Oster, M., & Gross, J. (2017). Unrealized potential: Community college pathways to STEM Baccalaureate degrees. *The Journal of Higher Education*, *88*(3), 430–478.

Baker, R. (2018). Understanding college students' major choices using social network analysis. *Research in Higher Education*, *59*(2), 198–225. https://doi.org/10.1007/s11162-017-9463-1

Barter, C., & Renold, E. (2000). 'I wanna tell you a story': Exploring the application of vignettes in qualitative research with children and young people. *International Journal of Social Research Methodology*, *3*(4), 307–323.

Berkman, L. F., & Glass, T. A. (2000). Social integration, social networks, social support, and health. In Berkman, L. F., & Kawachi, I. (Eds.), *Social Epidemiology* (pp. 137–173) New York, NY: Oxford University Press.

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2018). *Analyzing Social Networks* (2nd ed.). Los Angeles, CA: Sage.

Bourdieu, P. (1985). The forms of capital. In Richardson, J. G. (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241–258) New York, NY: Greenwood.

Breiger, R. L. (2021). A concluding comment: Toward a critical social network analysis. *Social Networks*, *67*(2), 74–75. https://doi.org/10.1016/j.socnet.2020.12.004

Burgess, L. G., Riddell, P. M., Fancourt, A., & Murayama, K. (2018). The influence of social contagion within education: A motivational perspective. *Mind, Brain, and Education*, *12*(4), 164–174. https://doi.org/10.1111/mbe.12178

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of sociology*, *94*, 95–120.

Colina Neri, R., Zipin, L., Rios-Aguilar, C., & Huerta, A. H. (2021). Surfacing deep challenges for social-educational justice: Putting funds, wealth, and capital frameworks into dialogue. *Urban Education*, *0*(0), 1–27. https://doi.org/10.1177/00420859211016520

Community College League of California. (2015). *Fast Facts 2015*. October 13, 2023, from https://www1.marin.edu/sites/default/files/California%20Community%20College%20Fast%20Facts.pdf

Cresswell, J. W., & Cresswell, J. D. (2017). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (5th ed.). Los Angeles, CA: Sage.

Daly, A. J. (2010). *Social network theory and educational change*. Cambridge, MA: Harvard Education Press.

Denton, M., Borrego, M., & Boklage, A. (2020). Community cultural wealth in science, technology, engineering, and mathematics education: A systematic review. *Journal of Engineering Education*, *109*(3), 556–580. https://doi.org/10.1002/jee.20322

Emerson, R. M., Fretz, R. I., & Shaw, L. L. (2011). *Writing Ethnographic Fieldnotes* (2nd ed.). Chicago, IL: The University of Chicago Press.

Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review*, *81*(2), 209–241.

Froehlich, D. E., Rehm, M., & Rienties, B. C. (2020). *Mixed Methods Social Network Analysis: Theories and Methodologies in Learning and Education*. London, UK: Routledge.

Geertz, C. (1973). "Thick Description: Toward an interpretive theory of culture." In: *The Interpretation of Cultures*, New York, NY: Basic Books, 310–323.

Gonzalez Canche, M. S., & Rios-Aguilar, C. (2015). Critical social network analysis in community colleges: Peer effects and credit attainment. *New Directions for Institutional Research*, *2014*(163), 75–91. https://doi.org/10.1002/ir.20087

Graham, M. J., Frederick, J., Byars-Winston, A., Hunter, A. B., & Handelsman, J. (2013). Increasing persistence of college students in STEM. [Editorial Material]. *Science*, *341*(6153), 1455–1456. https://doi.org/10.1126/science.1240487

Granovetter, M. S. (1973). The strength of weak ties. *American Journal of sociology*, *78*(6), 1360–1380.

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review*, *29*(6), 911–922. https://doi.org/10.1016/j.econedurev.2010.06.010

Grunspan, D. Z., Wiggins, B. L., & Goodreau, S. M. (2014). Understanding classrooms through social network analysis: A primer for social network analysis in education research. *CBE—Life Sciences Education*, *13*, 167–178. doi: 10.1187/cbe.13-08-0162

Hagedorn, L. S., & Purnamasari, A. V. (2012). A realistic look at STEM and the role of community colleges. *Community College Review*, *40*, 145–164.

Hall, R. M., & Sandler, B. R. (1982). *The classroom climate: A chilly one for women?* [Project on the Status and Education of Women.] Washington, DC: Association of American Colleges. Retrieved October 13, 2023, from http://eric.ed.gov/ERICWebPortal/search/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED215628 &ERICExtSearch_SearchType_0=no&accno=ED215628

Herrera, F. A., Kovats Sánchez, G., Navarro, M., & Zeldon, M. J. (2018). Latinx students in STEM college pathways: A closer look at diverse pathways through Hispanic Serving Institutions (HSIs). In Yuen, T. T., Bonner, E., & Arreguín-Anderson, M. G. (Eds.), *(Under)Represented Latin@s in STEM: Increasing Participation Throughout Education and the Workplace* (pp. 3–18). New York, NY: Peter Lang Publishing.

Hudelson, P. M. & World Health Organization: Division of Mental Health. (1994) *Qualitative research for health programmes /Patricia M. Hudelson*. World Health Organization. Retrieved October 13, 2023, from https://apps.who.int/iris/handle/10665/62315

King, R. B., & Mendoza, N. B. (2021). The social contagion of students' social goals and its influence of engagement in school. *Learning and Individual Differences*, *88*, 102004. https://doi.org/10.1016/j.lindif.2021.102004

Koenig, R. (2009). Minority retention rates in science are a sore spot for most universities. *Science*, *324*(5933), 1386–1387.

Kvale, S., & Brinkmann, S. (2009). *InterViews: Learning the craft of qualitative research interviewing* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Laanan, F. S., Starobin, S. S., & Eggleston, L. E. (2011). Adjustment of community college students at a four-year university: Role and relevance of transfer

student capital for student retention. *Journal of College Student Retention Research Theory and Practice*, *12*, 175–209. https://doi.org/10.2190/cs.12.2.d

Lin, N., Ensel, W. M., & Vaughn, J. C. (1981). Social resources and occupational status attainment. *Social Forces*, *59*, 1163–1181.

Malcolm, S., Hall, P., & Brown, J. (1976). *The Double Bind: The Price of Being a Minority Woman in Science*. Washington, DC: American Association for the Advancement of Science.

Malcolm, L., & Malcolm, S. (2011). The double bind: The next generation. *Harvard Educational Review*, *81*(2), 162–172.

Marsden, P. V., & Campbell, K. E. (1984). Measuring tie strength. *Social Forces*, *63*(2), 482–501.

McCarthy, C., Lubbers, M. J., Vacca, R., & Molina, J. L. (2019). *Conducting Personal Research Network Research: A Practical Guide.* New York, NY: The Guilford Press.

Mein, E., Esquinca, A., Monarrez, A., & Saldaña, C. (2020). Building a pathway to engineering: The influence of family and teachers among Mexican-origin undergraduate engineering students. *Journal of Hispanic Higher Education*, *19*(1), 37–51.

Metcalf, H. (2016). Broadening the study of participation in the Life Sciences: How critical theoretical and mixed-methodological approaches can enhance efforts to broaden participation. *CBE—Life Sciences Education*, *3*(15), 1–11.

Mobley, C., & Brawner, C. E. (2019). "Life prepared me well for succeeding": The enactment of community cultural wealth, experiential capital, and transfer student capital by first-generation engineering transfer students. *Community College Journal of Research and Practice*, *43*(5), 353–369. https://doi.org/10.1080/10668926.2018.1484823

Newman, M. E. J. (2003). Ego-centered networks and the ripple effect. *Social Networks*, *25*(1), 83–95. https://doi.org/10.1016/S0378-8733(02)00039-4

Ngai, C., Pilgrim, M. E., Reinholz, D. L., Corbo, J. C., & Quan, G. M. (2020). Developing the DELTA: Capturing cultural changes in undergraduate departments. *CBE—Life Sciences Education*, 19:aR15, 1–14. https://doi.org/10.1187/cbe.19-09-0180

Oh, S. S., & Lewis, G. B. (2011). Stemming inequality? Employment and pay of female and minority scientists and engineers. *The Social Science Journal*, *48*, 397–403.

Olson, S., & Labov, J. B. (2012). *Community Colleges in the Evolving STEM Education Landscape: A Summary of a Summit,* Washington, DC: National Academies Press.

Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in Science, Technology, Engineering, and Mathematics. *Harvard Educational Review*, *81*(2), 172–208.

Otte, E., & Rousseau, R. (2002). Social network analysis: A powerful strategy, also for the information sciences. *Journal of Information Science*, *28*, 441–453. https://doi.org/10.1177/016555150202800601

Packard, B. W., Gagnon, J. L., LaBelle, O., Jeffers, K., & Lynn, E. (2011). Women's experiences in the STEM community college transfer pathway. *Journal of Women and Minorities in Science and Engineering*, *17*(2), 129–147. https://doi.org/10.1615/JWomenMinorScienEng.2011002470

Park, K. (1999). "I Really Do Feel I'm 1.5": The construction of self and community by young Korean Americans. *Amerasia Journal*, *25*(1), 139–163.

Patton, M. Q. (2015). *Qualitative Evaluation and Research Methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

Perez-Felkner, L. (2015). Perceptions and resilience in underrepresented students' pathways to college. *Teachers College Record*, *117*(8), 1–60.

Perry, B. L., Pescosolido, B. A., & Borgatti, S. P. (2018). *Egocentric Network Analysis: Foundations, Methods, and Models*. Cambridge, UK: Cambridge University Press.

Provasnik, S., & Planty, M. (2008). *Community colleges: Special supplement to the condition of education 2008* (NCES 2008-033). Washington, DC: U.S. Department of Education: Institute for Education Sciences. http://nces.ed.gov/pubs2008/2008033.pdf

Reyes, M. (2011). Unique challenges for women of color in STEM transferring from community colleges to universities. *Harvard Educational Review*, *81*(2), 241–262.

Rincón, B., Fernández, E. F., & Dueñas, M. C. (2020). Anchoring comunidad: How first-and continuing-generation Latinx students in STEM engage community cultural wealth. *International Journal of Qualitative Studies in Education*, *33*(8), 840–854. https://doi.org/10.1080/09518398.2020.1735567

Rincón, B., Fernández, E. F., & Hinojosa, J. J. (2020). "I want to follow in her footsteps": Activating, nurturing, and extending community cultural wealth for students of color entering STEM pathways. *Teachers College Record*, *122*(9), 1–36.

Rincon, B., & Rodriguez, S. L. (2021). Latinx students charting their own STEM pathways: How community cultural wealth informs their STEM identities. *Journal of Hispanic Higher Education*, *20*(2), 149–163. https://doi.org/10.1177/1538192720968276

Rios-Aguilar, C. (2014a). The changing context of critical quantitative inquiry. *New Directions for Institutional Research, Special Issue: New Scholarship in Critical Quantitative Research Part 1*, *158*, 95–107.

Rios-Aguilar, C. (2014b). Using big (and critical) data to unmask inequities in community colleges. *New Directions for Institutional Research, Special Issue: New Scholarship in Critical Quantitative Research Part 2*, *163*, 43–57. https://doi.org/10.1002/ir.20085

Rios-Aguilar, C., & Deil-Amen, R. (2012). Beyond getting in and fitting in: An examination of social networks and professionally relevant social capital among Latina/o university students. *Journal of Hispanic Higher Education*, *11*(2), 179–196. https://doi.org/10.1177/1538192711435555

Robnett, R. D. (2016). Gender bias in STEM fields: Variation in prevalence and links to STEM self-concept. *Psychology of Women Quarterly*, *40*(1), 65–79. https://doi.org/10.1177/0361684315596162&

Ruiz Alvarado, A. (2014). *Latina/o Pathways Through College: Characteristics of Mobile Students and the Institutional Networks They Create*. (Unpublished Dissertation). Los Angeles, CA: University of California.

Saldana, J. (2021). *The Coding Manual for Qualitative Researchers* (4th ed.). Thousand Oaks, CA: Sage.

Samuelson, C. C., & Litzler, E. (2016). Community cultural wealth: An assets-based approach to persistence of engineering students of color. *Journal of Engineering Education*, *105*(1), 93–117. https://doi.org/10.1002/jee.v105.1

Seidman, I. (2019). *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences* (5th ed.). New York, NY: Teachers College Press.

Schinske, J. N., Balke, V. L., Gita Bangera, M., Bonney, K. M., Brownell, S. E., Carter, R. S., … & Corwin, L.A., (2017). Broadening participation in Biology education research: engaging community college students and faculty. *CBE—Life Sciences Education*, *16*(mr1), 1–11. https://doi.org/10.1187/cbe.16-10-0289

Small, M. L., Perry, B. L., Pescosolido, B. A., & Smith, E. B. (2021). *Personal Networks: Classic Readings and New Directions in Egocentric Analysis*. Cambridge, UK: Cambridge University Press.

Sonnert, G., Fox, M. F., & Adkins, K. (2007). Undergraduate women in science and engineering: Effects of faculty, fields, and institutions over time. *Social Science Quarterly*, *88*(5), 1333–1356.

Spradley, J. P. (1979). *The ethnographic interview*. New York, NY: Holt, Rinehart & Winston.

Starobin, S. S., Jackson Smith, D., & Laanan, F. S. (2016). Deconstructing the transfer student capital: Intersect between cultural and social capital among female transfer students in STEM fields. *Community College Journal of Research and Practice*, *40*(12), 1040–1057. https://doi.org/10.1080/10668926.2016.1204964

Wang, X., & Wickersham, K. (2018). Women, community colleges, and STEM careers. *New Directions for Institutional Research*, *179*, 73–90.

Wasserman, S., & Faust, K. B. (1994). *Social Network Analysis: Methods and Applications*. Cambridge, UK: Cambridge University Press.

Watts, D. J. (2003). *Six Degrees: The Science of a connected age*. New York, NY: W.W. Norton & Co.

Yap, M. C. (2022). Centering from the margins: The standpoint of women of color STEM majors in the community college. In Khan, S. A., & Unruh, K. (Eds.), *Beyond Equity at Community Colleges: Bridging Theory into Practice for Justice and Liberation* (pp. 102–119). New York, NY: Routledge.

Yosso, T. J. (2005). Whose culture has capital? A critical race theory discussion of community cultural wealth. *Race, Ethnicity and Education*, *8*(1), 69–91. https://doi.org/10.1080/1361332052000341006

Zuckerman, A. L., & Lo, S. M. (2021). Transfer student experiences and identity navigation in STEM: Overlapping figured worlds of success. *CBE—Life Sciences Education*, *20*(ar48), 1–24. doi: 10.1187/cbe.20-06-0121