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The influence of expressive and instrumental social capital from parents on women and underrepresented minority students' declaration and persistence in engineering majors

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Abstract

Background: Social capital, defined as the people one knows and the resources available through that network of people, has been a key variable in research examining the participation of women and underrepresented minority students in science, technology, engineering, and mathematics (STEM). This study focuses on two types of social capital: instrumental (concrete advice and resources) and expressive (emotional support and encouragement). The analysis of interviews with 55 White women and women and men underrepresented minority engineering undergraduate students shows how the instrumental and expressive social capital received from parents influenced their students' declaration of and persistence in the engineering major. Within this analysis, we considered students' transition to adulthood and the corresponding expectation that parents would still provide support but allow their children to independently determine their own paths.

Results: Participants shared the advice they received from people in their social networks, with the majority of participants highlighting parents as a major contributor of instrumental and expressive social capital. Instrumental social capital was helpful in students' major declarations and offered them an opportunity to further develop their interests and aptitude in STEM as well as a pathway for obtaining an engineering degree. During the first year of their engineering major, students relied heavily on the expressive social capital of parents when considering whether to stay in engineering; parental encouragement of "you can do it" became a common resource.

Conclusions: These findings offer nuance to explanations of social capital's influence on STEM degree major declaration and persistence, which often use deficit approaches. In highlighting the resources of social capital, especially expressive support, this work offers educators a new frame of reference for building upon the valuable advice offered by parents to their children completing engineering majors.

Keywords: Engineering education, Social capital, Parents, Social emotional support

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Introduction

Families of origin are known to be important sources of career decision-making, including in students' pursuit of and choices for higher education (Whiston & Keller, 2004). Research shows that families, particularly parents, are perhaps the *greatest* influencers of their children's higher education decisions (Huang & Liang, 2016; Kriegbaum, Villarreal, Wu, & Heckhausen, 2016). Decades of STEM education research demonstrates that parents and families can be crucial to students' early interest in STEM and decisions to declare STEM college majors, and to their persistence once enrolled (Adelman, 1998; Dabney, Chakraverty, & Tai, 2013; Goodman et al., 2002; Mannon & Schreuders, 2007; Martin, Simmons, & Yu, 2014; Seymour & Hewitt, 1997; Talley & Ortiz, 2017; Winters, Matusovich, & Brunhaver, 2014).

Although some researchers describe how having an engineer parent or other family member gives pre-college and college students tacit knowledge about the field (e.g., Mannon & Schreuders, 2007), others have demonstrated that it is not necessary for a parent to have an engineering background to provide crucial support. For example, Simmons and Martin (2014) found that parents—and in particular, mothers—provide important emotional support for first-generation college students in engineering even though the parents themselves never earned a college degree. In another example, Mein and colleagues emphasized the role of fathers in Mexican-American students' decisions to pursue engineering, finding that while students who had engineer fathers engaged in “engineering talk and activities” from an early age, students without engineer fathers still engaged in engineering-related activities that involved hands-on problem-solving (Mein, Esquinca, Monarrez, & Saldaña, 2020, p. 48).

Our work focuses on parental support during their students' transition to college. College entry is a pivotal transition in a person's life; they develop needed workforce skills and build capital that will be vitally important when entering adulthood (Furstenberg, 2008; Lui, Chung, Wallace, & Aneshensel, 2014). The college transition coincides with the transition to adulthood, as adolescents often move away from parents, become more self-reliant, and engage new peer groups, all while their educational pursuits become more difficult (Lui et al., 2014; Pancer, Hunsberger, Pratt, & Alisat, 2000). During this transition, many parents provide ongoing financial and social-emotional support (Conger, Conger, Russell, & Hollis, 2013; Fingerman, Cheng, Tighe, Birditt, & Zarit, 2012; Thornton, Orbuch, & Axinn, 1995). This transitional support from parents can be viewed as *social capital*. We define social capital as the resources and knowledge available to students through their social networks (Lin, 2001). In the context of engineering

education, social capital can include both specific information about engineering and encouragement to pursue engineering despite perceived difficulties (Martin, Stefl, Cain, & Pfirman, 2020).

Multiple bodies of literature address the role of parents as important sources of social capital during college transitions. For example, the psychology literature suggests that parents are sources of support and advice for their children throughout their lives, solidifying their parental role as social capital “alters” (Conger et al., 2013; Fingerman et al., 2012). In the education literature, social capital is linked to parental expectations and aspirations, parental educational levels, parent-school involvement, and parent-child interactions (Dika & Singh, 2002). Research also demonstrates that parental support as a form of social capital eases the transition to college (Kim & Schneider, 2005; Mounts, Valentiner, Anderson, & Boswell, 2006; Zhang & Smith, 2011).

In this study, we explore how the parents of White women and women and men underrepresented minority (URM) students in engineering transmit the advice, knowledge, and resources that assist their students in making decisions to pursue and persist as engineering majors. In considering both the US' intense focus on recruiting and retaining more women of all racial and ethnic backgrounds and men who are underrepresented minority students to engineering, and the relative lack of progress in achieving that goal over the past four decades, we focus on groups designated as “underrepresented” by the National Science Foundation (2019): men and women who identify as Black/African American, Hispanic/Latino, and American Indian and Alaska Native, as well as White women.

Our theoretical use of social capital provides an assets-based framing of the “underrepresentation problem,” an issue too often characterized by deficit thinking focusing on the perceived inherent deficiencies of individual students (Solórzano & Yosso, 2002; Valencia, 1997). Social capital provides an assets-based (also called anti-deficit) framing by its focus on the *assets present in students' social networks*. Our research adds to the growing body of assets-based literature on underrepresented students in STEM (Castro, 2014; Johnson, Brown, Carlone, & Cuevas, 2011; Martin et al., 2020; Martin & Garza, 2020; Pawley, 2019; Rahm & Moore, 2016; Syed, Azmitia, & Cooper, 2011; Winterer, Froyd, Borrego, Martin, & Foster, 2020) by highlighting the capital present in their families, and by illustrating how underrepresented students use parental social capital to declare and then persist in undergraduate engineering majors.

Following Harper's recommendation to use anti-deficit frameworks to “explore and better understand the enablers of minority student achievement in STEM” (Harper, 2010, p. 64), our work considers this research

question: In what ways does social capital provided by parents contribute to White women and women and men underrepresented minority students' decisions to pursue and persist in engineering undergraduate degree programs?

Theoretical underpinnings

Some scholars have characterized social capital accruing at the societal (group) level, (Bourdieu, 1986; Coleman, 1988; Putnam, 1996), while others characterize it as accruing at the relational (individual) level (Burt, 1982; Lin, 1982; Marsden & Hurlbert, 1988; Portes & Sensenbrenner, 1993). Lin's network theory of social capital (Lin, 2001) focuses on the social networks of *individuals* and their networks of contacts, or "alters" (see also Burt, 1982; Lin, 1999; Son & Lin, 2012). The network theory of social capital asserts that, while it is possible for goals to be realized independently of one's social networks, the social capital embedded in the resources present in one's network of alters augments an individual's personal resources (Lin, 2001; Lin, 2008; Van der Gaag & Snijders, 2005). Network-based social capital is particularly important to undergraduate students, and participatory social capital accruing from participation in organizations can lead to a new group of alters (Skvoretz et al., 2020).

As a popular export from sociology into education over recent decades, social capital has been positively linked to educational achievement, attainment, and education-related psychosocial factors (e.g., Dika, 2003; Dika & Singh, 2002; Huang & Liang, 2016; Kriegbaum et al., 2016; Pascarella, Pierson, Wolniak, & Terenzini, 2004; Portes, 1998). In the field of engineering education, engineering students' social capital has been positively linked to their academic achievement, grade point average, engineering identity, retention, and self-confidence (Boone & Kirn, 2016; Brown, Flick, & Fiez, 2009).

By adopting Lin's relational conceptualization of social capital, we are able to explore how social relations influence individual student's academic decision-making, specifically their selection of and persistence in undergraduate engineering studies. In this context, social capital is defined as a pool of resources that can be accessed and activated to achieve success for students in making the decision to major in engineering and to persist in their undergraduate studies (Lin, 2001). The persons (e.g., parent, teacher) who influence a particular student's decision-making comprise the student's network of alters. Students access the available social capital in their network through interactions with alters. For this article, the social capital provided by parents as alters is particularly salient.

Here, we investigate two types of social capital: *expressive* and *instrumental*. Van der Gaag and Snijders (2005) define instrumental social capital as obtaining resources to help one achieve a goal (e.g., advice to take certain classes), and expressive social capital as having the goal of emotional support, physical and mental health, and life satisfaction (e.g., encouragement to not give up). Lin (2001) specifies that expressive actions are related to "sentiment or support" (p. 46). These may help maintain and reinforce both existing resources and emotional or physical wellbeing by providing "attention, care, companionship, love, and various other resources" (Lin & Erickson, 2008, p. 28). Such advice, which helps shape students' emotional wellbeing, including their understanding of engineering culture and their place within it (Smith et al., 2015), could be influential in their persistence in engineering. In particular, expressive social capital is consistent with close ties (Granovetter, 1973; Lin, 2001) such as those present in familial relationships, especially with parents. In contrast, instrumental actions provide an individual with new or additional resources that help achieve a specific goal (Lin, 2001; Son & Lin, 2012). In post-secondary education, instrumental actions by alters would, for example, help students successfully complete their college degrees. In social relationships in which the ties are strong—that is, they are characterized by "intensity, intimacy, frequency of contacts" (Lin, 2001, p. 67)—resources are more likely to be shared and exchanged.

Methods

Research design

To answer our research question, we used interview data from our mixed methods longitudinal study that examined how social capital contributed to the persistence of White women and women and men underrepresented minorities (as defined by the National Science Foundation) in engineering undergraduate programs. In spring 2015, this study administered online surveys to a cohort of engineering undergraduates recruited from 11 universities across the USA. These universities included seven predominantly White institutions (PWIs), three Hispanic-serving Institutions (HSIs), and one Historically Black College/University (HBCU). Among other items, the surveys inquired about (1) student demographics, (2) alters who influenced students' decisions to pursue engineering and their persistence in engineering programs, and (3) use of resources to achieve success in engineering, beginning in their first year in the program. In addition, interviews were conducted with a subset of White women and women and men URMs who responded to the first survey, including both students who persisted in the engineering program and those who had switched to other majors or who were in the

process of switching. The interviews collected rich, in-depth data about the social capital brought by students into their engineering programs and acquired through their relationships with alters in their social networks. Questions focused on experiences in the first year of the students' engineering programs, thus the experiences of the 50 students who remained in engineering as of the second year and of the five students who switched were comparable since all were engineering majors during the first year. See Skvoretz et al. (2020) for a complete description of the surveys and research design. This paper focuses specifically on the analyses of the interview data. Demographic information about the interviewed students compiled from the surveys included gender, race/ethnicity, level of parents' education, and financial status during first year of the engineering program, and is presented as frequencies to both describe the sample and aid in interview analysis.

Interview protocol

Focused exclusively on students' experiences in high school and their first year as engineering undergraduates, the interview protocol included retrospective questions about why they decided to pursue engineering and about their relationships with those identified in their survey responses as having influenced their decisions to pursue the engineering major. Questions also asked participants to describe the types of advice provided by alters (i.e., individuals in their network), how they acted on this advice, and how it influenced their decisions to major in engineering. The interview protocol included "tell-me-more" probes and requested examples that encouraged students to provide more details (Bernard, 2011). The interview protocol was pilot-tested with two engineering undergraduate students who were outside the study. Their feedback was used to clarify and revise questions and finalize the interview protocol.

Sample selection

The interview participants were from five universities (one PWI ranked nationally among the top five public universities; two other large, state PWIs; an HSI; and an HBCU). These universities were selected because they provided an opportunity to study White women and women and men URMs in diverse learning environments and contexts. Survey respondents were selected for interviews based upon their probability of social capital activation, a dichotomous ego-network variable calculated through online survey responses that indicated whether or not a student (ego) used resources available and accessible through identified alters in their network (1 = Activated, 0 = Not Activated). Selecting as covariates items measuring academic preparation, persistence and success, resources, department support,

relationships and support, and fit, probabilities were generated from a logistic regression model to identify participants with low and high probabilities of activation. Members of the lowest strata and the highest strata were then selected for potential interview participation to obtain a diverse sample of participants. A total of 55 students agreed to be interviewed. Forty-two of the interviewees were from three PWIs, eight from an HSI, and five from the HBCU. This sample included women of any racial/ethnic grouping as well as URM men studying engineering.

Data collection

Three interviewers conducted the 55 interviews in person or via videoconference, either at the end of the second semester of participants' second year (spring 2016) or at the beginning of the first semester of participants' third year (fall 2016). Before each interview, interviewers used the students' survey responses to personalize the interview protocol, particularly in terms of their relationships to the alters they indicated had influenced them. This personalization included both the students' and alters' racial/ethnic and gender identities. For example, if a student named her advisor, a Hispanic female, as an influential person, her interview instrument included this information and a prompt to ask about this particular person with these characteristics (e.g., "please tell me about your advisor, a Hispanic female"). This procedure allowed us to confirm that the participant was referring to the same person as noted on the survey.

Prior to the semi-structured interviews, students received detailed informed consent forms approved by the funded university's Institutional Review Board. Each interview lasted from 20 to 60 min. Most were conducted in-person on the respective college campuses, while seven were conducted via Skype when students were unable to meet on campus. All interviews were audio-recorded and transcribed verbatim by a professional transcriptionist. Each respondent received a \$25 electronic Amazon card for participating.

Data analysis

As outlined in Campbell, Quincy, Osserman, and Pedersen (2013), the research team analyzed the interviews using a three-step process. We developed a coding scheme and established inter-rater reliability based on a sample of transcripts, discussed disagreements about coded data in order to reach consensus, and coded the full sample of interview transcripts using the finalized coding scheme. In this paper, we report on the interview analysis, focusing specifically on participants' responses about how parents served as social capital alters.

Code book development

Prior to analyzing the data, five research team members used the research questions and interview protocol as a guide to create and refine a codebook (Ryan & Bernard, 2003). The codebook included 46 primary codes and sub-codes consistent with the constructs of social capital, with seven additional distinctions by code based on type of alter (e.g., parent, peer). Once consensus was reached on the codebook, the team coded two interviews together to test the usability of the codebook and make additional refinements (DeCuir-Gunby, Marshall, & McCulloch, 2011). As part of this process, codes were clarified and examples were added to the codebook to support the appropriate interpretation of each construct. To test the efficacy of the codebook, each researcher coded three interviews independently to determine ease of use and to make additional refinements. The team then evaluated the codes based on their coding experiences and finalized the hierarchical coding structure together (Thomas, 2006).

Coding the data

After the final codebook was developed, two members of the research team coded a final interview to establish inter-rater reliability through a line-by-line comparison of their respective coding (Bernard, 2011). Inter-rater reliability was calculated by dividing the number of lines for which researchers independently coded with the same code by the total number of lines of text in the interview. The inter-rater reliability was 90% when determining level of agreement for primary codes only. That is, for passages that were double or triple coded, the coders shared at least one code 90% of the time, even if they did not both use additional codes for the passage. Inter-rater reliability was 83% when determining level of agreement for both primary and secondary codes, which we deemed sufficient to move forward, as 80% reliability is widely considered the benchmark (Krippendorff, 2003; Landis & Koch, 1977). The two coders each coded half of the interview transcripts on paper and another member of the qualitative team entered the codes into the QSR NVivo 11.0 software.

Because there were areas of disagreement about when to deploy certain sub-codes, and to ensure that the most meaningful and accurate information would be reported, the team determined that a second level of coding was required. Specifically, our team could not consistently agree about the distinction between “expressive” and “instrumental” social capital. Therefore, one author, an expert in social capital theory, conducted a second round of coding for all interview passages initially coded as *advice*, including information and support (i.e., social capital), and *activation* of advice during the first round of coding. This author examined the passages to determine

whether they were “instrumental” or “expressive” social capital.

Thematic content analysis

Thematic content analysis (Bazeley & Jackson, 2013; Braun & Clarke, 2006; Burnard, Gill, Stewart, Treasure, & Chadwick, 2008; Thomas, 2006) was used on the coded interview passages. Any information/advice/actions of alter(s) that influenced a respondent’s decision to pursue engineering and any information/advice/actions that influenced a respondent during the first year of college were coded as advice. Trends were identified based on the frequency or patterned nature of responses as well as their “keyness,” or whether the data capture something essentially related to the research questions (Braun & Clarke, 2006, p. 82). These trends were grouped into emergent themes, and illustrative excerpts were identified to demonstrate salient points captured by the theme. While we had separate codes for social capital advice and activation, interviewees did not make a distinction between the two in their answers. When asked what advice they received from their parents, students only talked about the advice or information they received and acted on; no one described advice from a parent that was not activated. Because these ideas are inextricably linked in the answers, we do not speak about advice and its activation separately throughout the results.

We considered intersectionality in our analysis, but we found no differences in responses based on race/ethnicity and/or gender; this may be due to our small sample size of nine minority women. While we recognize the intersectional experience of the women of racial/ethnic minority groups in our sample, understanding that their multiple identities subject them to “double-discrimination” (Crenshaw, 2011), we found that the experiences of these nine minority women with parental social capital were not different from the other study participants.

Results

In general, students reported accessing social capital during high school primarily through parents, other family members, and teachers. More students, 42 of 55 participants, talked about parents as influencers than any other type of alter, thus this analysis focuses on them. Parents provided social capital as both instrumental and expressive advice, information, and support when students were choosing a major and throughout their first year of college. Students relied on their parents especially closely as they were making the crucial decision to persist in or switch from their engineering majors. When working through the decision to persist in engineering or not, students mentioned receiving instrumental support from parents (nine students), peers (two

students), and high school teachers or college professors (two students). They also mentioned receiving expressive support from parents (23 students), peers (five students), and high school teachers or college professors (eight students). Additionally, more than twice the number of participants reported that parents' expressive advice, information, and actions were integral to their decision-making as those who reported that parents' instrumental advice, information, and actions were important.

Characteristics of sample

We examined race/ethnicity, gender, and parents' highest level of education in our analyses for possible differences in answers about parental social capital. Students from all racial/ethnic and gender groups talked about their parents as alters and provided similar information about parental advice and support. Demographic and academic characteristics of the sample were collected through surveys 1 and 2, and are detailed in Table 1.

Participants self-identified gender and race/ethnicity; the category "Middle Eastern" was included based on proposed revisions of the US Census instrument prior to the start of our study in 2014. In order to provide a deeper description of the students in this sample, additional demographic and academic information was included: academic standing based on accumulated credit hours,

grade point average (GPA), employment status in student's first year, and financial status in student's first year. Most students (32 students) were juniors in the fall of their third year, and 90% (46 students) had a GPA over 2.5. During the first year of their engineering program, 47% (24 students) did not work at all. Four students had federal work study, and only one student was employed full-time. Two-thirds of the students (34 students) had sufficient funds to meet their needs and did not mention any financial stress. This racially/ethnically diverse sample of White women and women and men URM shared many other characteristics such as academic standing, GPA, and employment status. The majority of our sample was financially stable, did not work much, and had good grades. This could explain why students spoke similarly about social capital and why our sample shared so many similar success stories.

These students' parents had similar educational characteristics as well; 67% of parents who provided instrumental support and 61% of parents who provided expressive support had a Bachelor's degree or higher. Additionally, 22% of parents who provided instrumental support and 17% of parents who provided expressive support had not attended any college. In this sample of 55 gender and racially/ethnically diverse students, 60% had at least one parent who had received a Bachelor's

Table 1 Characteristics of interviewed students by race/ethnicity

	Black/African American	Hispanic/Latinx	White	Middle Eastern	Other	Total
Gender						
Female	6	3	14	0	1	24
Male	11	15	0	3	2	31
Current academic standing						
Freshman	0	1	0	0	0	1
Sophomore	2	5	1	0	1	9
Junior	9	10	9	3	1	32
Senior	5	1	2	0	1	9
Current GPA						
3.51 or more	5	3	1	0	1	10
2.51–3.5	10	11	10	3	2	36
2.5 or less	1	3	1	0	0	5
Employment status, first year						
did not work	9	9	6	0	0	24
part-time /summer employment	6	6	5	3	2	22
federal work study	1	1	1	0	1	4
full-time employment	0	1	0	0	0	1
Financial status, first year						
sufficiently funded	11	11	10	2	0	34
some financial stress	2	0	1	1	0	4
financial stress	3	6	1	0	3	13

degree or higher and 80% had at least one parent who had attended some college. These similarities may have accounted for the widespread availability of parental social capital, both instrumental and expressive, in our sample. Additionally, the relatively high educational attainment of the students' parents may explain why these students have increased access to instrumental advice, information, and actions from parents. Having attended at least some college, parents had some firsthand knowledge to relate about the college experience. Parents' connection to engineering differed—some were engineers themselves and others worked in industries that employ engineers. Some parents worked in technical jobs such as mechanic, information technology, construction, or electrician, while others had no apparent connection to engineering.

Instrumental advice from parents

We found several types of instrumental social capital provided by parents to students as they considered declaring and persisting in their engineering major. For example, parents recommended students pursue a major in engineering when they recognized specific talents or skills in mathematics, science, and/or observed that the students had a predilection for hands-on work. Parents also facilitated opportunities for their children to participate in STEM courses, special programs, or college/career fairs that gave them information about pathways to pursue engineering. Importantly, parents advocated that their children earn a college degree in order to secure their financial futures. Parents likewise provided instrumental social capital to their college students via advice that was not necessarily related to their engineering major, but that was considered general recommendations such as attending professors' office hours.

Declaring the engineering major

In response to the interview question asking why the participant decided to pursue engineering, students reflected on experiences from childhood, high school, and the first year in their engineering program. Their parents' jobs influenced students in that seeing their parents in engineering-related professions exposed students to the field and made them feel like it was something that they could do themselves.

Connecting math and science skills with engineering

Twenty-two percent of parents who provided instrumental social capital did so by connecting students' good grades and interest in science and math with engineering. Some parents told their children that engineering was a good field for someone who was good at mathematics and science. A White woman from a PWI explained, "My parents actually said, ... I've always liked

math and science and ... I would take ... extra math classes earlier so they kind of suggested [engineering]." A Middle Eastern man from a PWI was similarly encouraged by his father.

He knew I was good at those subjects that dealt with mathematical concepts and so he felt that [engineering] would be a much better choice to go with. ... he kind of kept pressing me on going with engineering, and I also felt that I like engineering, so it wasn't something that I wasn't really going for, it was something that I was very much comfortable with.

Facilitating student participation in STEM activities

Parents enrolled their children in magnet schools for the sciences or other special programs for mathematics, science, or engineering; 39% of parents provided this type of support. For instance, a Black man from an HBCU attended a magnet school and was influenced by his father to pursue engineering.

My dad didn't really talk much, but when we did it'd always be about ... the future, and ... what would be ... a good career and a good job, and ... I remember him talking to me about how I was in the engineering magnet [school], how... engineering's a good major, and how... we need more Black people in engineering. And how he believes that all the [immigrant] Americans that are in America today should ... pick up something like engineering.

A Black man at a PWI similarly described his mother's role in his ultimate selection of engineering.

I guess it really started at a very early age for me, my mom put me in a program ... an introductory kind of summer camp/afterschool activity program where you go every Saturday during the school year, and they even have camps during the summer too ... They kind of ... spark or cultivate your interest in engineering at an early age. And so, you do little fun projects and learn about [science and engineering] ... [In] kindergarten, I think, we learned about molecules ... as we progressed through the program through the years, we learned [more] ... we launched rockets...we applied some of the aspects of that into our learning. And just basically I learned about, they just kind of teach little things about engineering, simple machines, stuff like that at an early age to kind of get you interested.

Even though his parents knew nothing about engineering, they thought he would like this because he liked

Legos, video games, and working with his hands. Another Black man from a PWI was also encouraged by his mother to participate in an engineering summer program in high school to help him get accepted to this PWI.

Some parents fostered their children's interest in math and science by taking them to college, career, and/or engineering fairs, usually at the local college or university. Two men from a PWI and a man from an HBCU had similar experiences of parents taking them to career fairs and other presentations about STEM. A White woman from a PWI explained how her mother brought her to the engineering fair at the university, which influenced her to take more STEM courses in high school.

I became interested when my parents took me to [the local PWI] engineering fair. And it was in eighth grade, and I realized that I really like math and science. So, a lot of the stuff that they were presenting was actually really interesting. So I decided to take an engineering class in high school, and that's when I really was like, 'I really want to do this, I really like it.' So I just continued with the engineering class in high school and did it in college.

Her mother, who worked at a cyber electronics company, was happy with her decision, but her father was the person who supported her the most. He took her on a college tour and set up an interview with the Dean of Engineering, who explained how Civil Engineering might be what she was looking for since she was interested in design and architecture. She said, "I realized that Dad was really just helping a lot. And I got a tour, ... got to meet all these people. And it really was just a time where I was like, my dad is really invested in this, and he really wants me to succeed."

Influencing career choice through parent occupation

One of the ways that students were encouraged to pursue engineering occurred not through direct, verbalized encouragement from their parents, but through seeing and being exposed to the field because their parents worked in an engineering-related job. For instance, three participants were influenced to study engineering because their parents were engineers, while other students were influenced by other related careers. In all, 28% of parents providing instrumental social capital had jobs that influenced students' decisions. For example, one student became interested in mechanical engineering because his father was a mechanic. Another, whose father was a geologist who works with engineers, became interested in engineering as a result of learning more about her father's work. An additional student was influenced by watching his father working as a welder and building

things. Finally, a student who went to work with her father in the Navy enjoyed watching people build things without a guide and was influenced to pursue engineering in that way. These students were influenced by the career choices of their parents who had college degrees as well as those who did not.

Connecting college and engineering with a secure future

Numerous participants recounted that their parents encouraged them to consider how their desired major could provide a good living and/or told students that the engineering field would provide steady, well-paying jobs. Forty-two percent of parents providing instrumental advice suggested this specifically. A Hispanic man from a PWI spoke about his father in that regard.

He didn't really give me much specific advice, he just told me ... do something that you're good at and do something that will make you enough money in the future. He really didn't want me to go into a field where there wasn't a lot of demand for the job ... He saw potential in me, so he wanted me to do something that was going to be challenging but also stimulating, and so he sort of knew that I liked math and that I liked stuff like that, so he pushed me toward engineering. And I feel like he was right to do so because I like it, and I'm looking forward to continuing it.

A Hispanic woman from a PWI was influenced by her mother's own education and her desire for her daughter to be financially secure. "[My mom said], 'You're going to college.' I didn't really have a choice. She's got two master's degrees. It's like, 'You can either go to college or prove to me that you can make lots of money without going to college.'"

Similarly, a Black man from an HBCU explained that his mother urged him to attend college and major in something that could give him a good life.

[My mother] didn't really know much about engineering ... but, I mean, she was always really pushing and it was like she wanted me to ... major in something that will bring up a great future and whatnot. So I mean that was the main push. She was always really big on education. She always said 'a mind is a terrible thing to waste'. So ... she was always a big influence.

Other students were similarly encouraged to choose a career in which it would be easier to find a job later. A Hispanic man from a PWI shared that his mother pushed him to consider how a particular major would impact his future stability.

[She] instilled in me that if I'm going to college that I need to choose a good career that will provide enough money for my family, and for me to be stable. And she knew that I liked math and science, and then she told me about engineering. And I just researched about it on the internet, and then that's why I chose it.

A White woman from a PWI had a similar experience and said that her mother wanted her "to have a ... stable career path and support myself." In addition to advice to their children about their financial futures, other parents told students to focus on something that they have the skills for so that they would do well in college.

Remaining an engineering major

In comparison to the instrumental advice parents gave their children in secondary school, their instrumental advice was less specific once students were in college, and could have pertained to any college student with any major. Participants' responses varied, but no responses included information particular to engineering even though 36 percent of parents provided instrumental social capital.

For instance, parents provided instrumental advice to their children with practical suggestions about how to deal with obstacles and be prepared. This advice included suggestions that students talk to professors when they did not understand something, engage in group work with peers or join a study group, study more than otherwise inclined, get a tutor, keep track of grades and do what needs to be done to pass a class, manage time better, or join professional societies. This kind of instrumental advice would have been valuable to any college student, not just engineering majors. However, given the roles that professional societies and group work play in STEM and engineering specifically, this advice certainly proved helpful to students.

Parents also provided financial support, helped students manage their lives, and cultivated students' beliefs in the necessity of jobs that provide a stable future. For example, a White woman from a PWI relied on her mother for financial and moral support. She shared, "[My mom] gives me money ... a continual amount of support, and she always ... works out my doctor's appointments so I don't have to worry about all of that. And so, she helps me out with being an adult." Because this student received so much help from her mother, she could focus on successfully navigating her engineering program.

Expressive advice from parents

When students were deciding on declaring and persisting in their college major, parents were a great source of

general emotional support and encouragement (i.e., expressive social capital). Many parents told their children that they just wanted them to be happy. Parents suggested that their children find something that they love to do, and this encouraged many students to choose engineering. More specifically, students with an affinity for mathematics and science and who liked to build things saw engineering as a path to a career that would make them happy. Additionally, parents sometimes generally encouraged their children to attend college (regardless of major), and often they encouraged students to pursue STEM or engineering specifically.

Declaring the engineering major

Students spoke of the expressive advice their parents provided as they were considering which major they should declare. This advice included parental encouragement to do what they loved and would make them happy, as well as parental expression of pride and approval for their children's major choices.

Encouraging a major that will make students happy

The most common response when students were asked about their parents' encouragement to pursue a major in engineering was that parents wanted them to do something that would make them happy, to do something that they loved. Forty-six percent of parents providing expressive social capital told students to focus on a discipline and career that would make them happy. A White woman from a PWI said that her father told her to "do something that you like to do ... put yourself in a position where you're going to want to be." A Hispanic man from a PWI spoke similarly of his parents' advice.

My parents have always been very supportive of what I chose to do. To them, it didn't really matter if I wanted to be a doctor, wanted to be an engineer, wanted to be a pilot. You know ... their advice wasn't specific to a career, it was more of an overview, like do what you think is right, do where your passion is ... Go into what your passion is, do something that you can do for the rest of your life ... And, it's more of a motivation and encouragement than it was of, 'Oh, you have to do this.' Or, 'This is the right path, this is the wrong path.' It was more of, 'See what you like, choose what you want to do, and you know we'll help you through.'

Conversely, a multiracial woman from an HSI recounted her mother's advice that was more specific regarding her major. She said that her mother always encouraged her to pursue a career and major relating to building since that is what she wanted to do. The woman said of her mother, "She knows I'm interested in

building stuff and ... building stuff from the ground up, and watching it work and grow.” She continued to say that her mother pushed her in the direction that she believed her daughter wanted to go.

Expressing pride and approval When asked how their parents influenced them to pursue a degree in engineering, many students, 24%, focused on their parents’ general support and encouragement to succeed. Several students spoke of being secure in the knowledge that their parents supported them no matter what.

In some cases, students wanted to do what was necessary to make their parents proud of them. A Hispanic man from a PWI said that it was important that his mother approved of his choices and that she did approve of his choice to go into engineering. For some students, a parent’s approval was the most important thing. A Hispanic man from an HSI explained how he was influenced by his mother.

My mom, she’s one of those old school people, and then I told her I was like, ‘Oh hey mom, I really like to do this. Don’t you think this is really fun?’ She’s like, ‘Yeah, yeah, it’s fun. I mean if you like it just go for it in your future.’ ... So then she really encouraged me. She just pushed me ... And it really just told me, if I really want to do something, I have to take a leap. So she was that person, absolutely, and I thank her for just being that way, being my mom ...

Remaining an engineering major

Students spoke of expressive social capital from their parents during their first year of engineering study as they were trying to decide whether or not to remain in the engineering major. This advice took the form of general support, including reminders to take care of themselves or, most commonly, reminders that students could do anything that they tried to do and that they should not give up on what they wanted.

Expressing confidence that students could succeed

The most common types of expressive advice that students received from their parents while in college included the sentiment “you can do it.” In fact, this was the participating students’ most common comment about parents, with 84% of parents providing expressive support through encouraging students by telling them that they could succeed. Many students did not question remaining in engineering, but others did. Especially for those considering leaving engineering, students reported that hearing others tell them that they could do it was the greatest motivator as they were deciding whether or not to remain. Of the 55 interviewees, 14 who were considering leaving their engineering programs specifically

mentioned this advice from parents. While the context of the advice varied, the meaning remained the same. Parents wanted their children to know that they could accomplish anything. For instance, a White woman from a PWI talked about how she just knew that her parents felt this way.

Because engineering ... for me at least, each year gets progressively harder. And it’s easy to want to just say, ‘I’m just going to transfer into another program ... or transfer to an easier school.’ So I would say... my parents always instilled in me ... Do my best, never give up. ... I’d always think back to them ... and I’d always try and keep going. It’s like it’s going to be worth it in the long run.

Sometimes parents offered this advice in specific contexts, and their advice was designed to help students see that while things were difficult at that time, they would get better. For example, a White woman from a PWI talked about how her father always calmed her down when she became stressed about grades or her classes being too difficult.

He’s like ... ‘You’re going to push yourself no matter what you do. You’re going to have the stress whether you do art history or if you do education or if you do engineering. So, why not go for what you really like? For what you really enjoy? Why not try? ‘Cause you’re going to have the same stress anyway.’ So he really just encouraged me to just push through all of my doubts about myself. And that was really just what was really, really helpful in me just moving past the one bad grade and going on.

A White woman from a PWI similarly relied on her parents’ encouragement when she was thinking about changing majors because engineering classes were difficult.

[My dad] was one of the people who gave me reassurance that my classes were supposed to be hard. But I was doing well in them, and just because I thought this particular exam was really hard didn’t mean that I couldn’t be an engineer. Which is, I think, why a lot of people drop engineering. They take a specific class, either have a bad teacher or get bad test grades, and then they get in their head that they can’t do it, and they just quit ...

Likewise, a Black woman from an HBCU was discouraged by the difficulty of engineering courses. She recalled, “I told [my dad] maybe the major wasn’t meant

for me if I'm already hitting this roadblock in this class. ... He told me that I just got started and not to give up."

Conversely, a Hispanic man from a PWI, who was worried about his general education requirements more than his engineering studies, talked to his father about it. His father told him to just get those things out of the way so he could start enjoying the classes he would like. The student shared, "[My dad] said, 'Don't worry, just get through [the general education curriculum], don't get discouraged. Look forward to the real particular stuff, the stuff that actually has to do with your field and your major.'" This student went on to take the difficult engineering classes and did well in them.

Most of the time, parents' advice was general, and students basked in the feelings of support from those around them. For example, a Black man from a PWI appreciated his father's support.

It was more so just the support saying that 'You can do it, son.' That's really that kind of stuff ... He just has that support saying, 'You can do it, I got you,' that kind of stuff. And 'I'll always be here,' so that's kind of the stuff he did, not too much of the advice and what to do and stuff like that. ... Just the encouragement and everything. I mean, just knowing that I can do it and so it was more so of just emotional [support] ... I know that I can do it, you know, I got people backing me. That's really it, you know.

A Hispanic man from a PWI spoke to his father every day. The student noted that the encouragement of his father is what kept him from switching out of the engineering major.

I always get a text from him during the day like, 'Hey, how's it going? What are you up to?' And, I'm like, 'Oh yeah, I'm in class, just stopped, knocking out these assignments, you know how it is.' And he'll tell me, 'Hey, just keep going. You don't have that much longer to go. You'll be able to make it with no problem, in no time. It's going to fly' ... I mean if it wasn't for that daily motivation, and if it wasn't for him always being there even in the times that I need him and don't need him, I probably would've switched to another major by now.

Another student, a Black woman from a PWI, spoke to her mother often. The student reflected on how her mother's advice influenced her to persist.

[My mother's] advice really sits with me and encourages me. And it reminds me that I do have a goal, and I have a passion. And that I shouldn't let

obstacles—especially the ones that are so nonsensical—I shouldn't allow them to keep me from doing what I want to do.

While these excerpts show that parents were a key factor in many students' persistence in their engineering major, when parents felt the major was no longer a good choice, they advised their children of other options. For example, a White woman from a PWI talked to her mother about whether or not to switch from engineering.

There were so many times when I just wanted to give up ... I just really doubted myself, especially after freshman year ... I came home exhausted not knowing what to do. And my mom, she saw how exhausted I was. And she threatened to take drastic measures ... [She told me,] 'You can't keep doing this to yourself. You know, maybe you should just go to a different college or maybe just stop going to college for a year or something like that.' So, the fact that I was so affected by how poorly I did my freshman year, and the fact that ... she was offering the option to leave the school that I loved ... Putting it that way made me really say, 'No, I can do this.'

This mother was so worried about her daughter that she suggested that maybe she take a break from school, but this student was so motivated by the fact that her mother cared so much and noticed her struggle that she decided to keep going. Her mother provided the emotional support that she needed.

Encouraging good health and habits Students talked about how their parents encouraged them to be healthy as well as happy. Forty-one percent of parents providing expressive social capital encouraged good habits for students as they progress through their studies and transition to adulthood. A Black woman from a PWI spoke about her mother's advice to focus on herself.

Well, other than 'Stay focused', my mother said, 'You really need to pray about things, you need to meditate, you need to slow down, you need to plan' ... Growing up, I was very disorganized. So she was like, that's one of the things I need to work on. She's like, 'Declutter.' And she's like, 'Run.' Because that's one of the ... things I loved to do to clear my mind. So she was like, 'Sometimes you need to take a break, you need to run, you need to skate.' She was like, 'I want you to enjoy your college experience.' She was like, 'Don't let it be all about your

academics, just stay on top of them.’ So there were just many, like, little things that she said, just to help me.

Such advice was echoed in guidance provided by other parents to their children. A White woman from a PWI noted that her mother’s advice was to manage her life and academics “by stepping back and just taking a breather.” Her mother also advised her not to worry after she did poorly in a math class in her freshman year and was considering switching majors. The student shared, “I did think about changing [majors] then. Just because I was like, ‘I don’t know if I can do it.’ And then my mom was like, ‘No, take a step back ... you can do it.’”

Discussion: the importance of expressive social capital

Parents play a critical role in influencing their children’s decisions about higher education (Huang & Liang, 2016; Kriegbaum et al., 2016). All our students who spoke about their parents offer examples of receiving instrumental and expressive advice, information, and actions from parents that guided their decisions. This social capital might change over time, as parents are more directional in support when children are young and more reserved as children age, but parents’ support of their children is constant. As participants noted, this contributes to their college success in general and in the engineering major specifically.

Our work contributes to the engineering education literature by promoting an assets-based theoretical stance that highlights the importance of academic and career-related social capital provided by parents. Our multi-institutional study identifies the specific types of social capital (expressive and instrumental) that parents provide. Expressive social capital is particularly salient as students consider pursuing and persisting in the engineering major. More than twice as many students in our study highlight expressive social capital over instrumental social capital when asked about parental advice and information that helped them decide to remain in engineering or switch majors. Parents provide general support and encouragement, and remind students that they can do anything they try. For this group of White women and women and men URM engineering undergraduates, expressive social capital is influential regardless of the parents’ educational background, occupation, or race/ethnicity. Importantly, this demonstrates that *all* students can possess capital that is critical to their engineering success; expressive social capital from parents is not limited to certain privileged groups.

Our finding that parents encourage their children to do what makes them happy and to do something they

love is consistent with findings from similar research. For instance, it aligns with Godwin, Potvin, and Hazari (2014), who examined specific mechanisms by which families have influence over students’ career choices, as well as Simmons and Martin (2014) and Martin et al. (2020), who examined familial influences on first generation college students’ persistence in engineering. Our finding that supportive parents are beneficial to their college-aged children is consistent with Kim and Schneider (2005), who examined the role of parents in the transition to post-secondary education.

When parents give instrumental advice to their college-aged children, it is often general, encouraging their children to try to succeed in college rather than trying to guide their children down a certain path. In fact, there is often an element of expressive support combined with instrumental support to seek out professors and study groups or to better track their grades. Thus, parents are not only telling their children they can succeed, but are providing ideas and possible steps to take to facilitate success. Often, discussions about how to succeed in college are followed by reminders that students should find something that makes them happy and that they are smart enough to successfully navigate college. Because 80% of students in our study have at least one parent who has attended some college, the parental knowledge base about college in general may increase the availability of instrumental social capital to participating students. Even so, the students in our sample report relying on expressive social capital from parents more often than instrumental social capital.

Students’ responses about advice and information from parents while in college and deciding to remain in engineering are consistent with the notion that parents provide support while allowing students to remain independent and decide their own course of study (Conger et al., 2013; Scheinfeld & Worley, 2018). Our sample did not include any students who indicated that their parents told them to remain or not remain in engineering, but 14 suggested that their parents encouraged them by telling them that they could do it if they continued to try. According to Scheinfeld and Worley (2018), young adults “may cycle between the need for support and the need for independence” (p. 449) in the transition to adulthood, and the participants demonstrate that they embrace this balance by leaning on their parents when needing support, but ultimately making their own decisions about engineering.

Implications

Our finding that parents, regardless of background, have similar influences on students via expressive social capital has important implications for engineering educators and educational researchers. Educators who recognize

and acknowledge familial social capital's significance will be better equipped to provide families with engineering career and college curricula resources to supplement the existing capital inherent in family relationships. Educators should not focus solely on providing instrumental social capital; they can also encourage families to leverage their existing expressive capital to help their students persist.

Conclusions

Explanations of differences in representation among groups in particular fields often compare social capital among certain social groups, arguing that some groups accrue educational disadvantages over time. Our findings caution against popular assumptions about social capital deficits, and favor a more nuanced, assets-based theoretical stance that may account for how familial capital can and does contribute to students' educational success.

Our findings suggest that parents are important influencers as their college students declare majors and decide over their first years to persist in that major. Parental social capital consists of instrumental and expressive advice, information, and actions provided by parents to their children. Instrumental social capital includes parents' connecting their students' interests and aptitudes in math and science to the engineering major, providing their children opportunities to participate in STEM activities inside and outside of school, helping students navigate their first college year, and suggesting that their children consider a stable financial future when choosing a career path. Parents also provide expressive social capital, valuable encouragement, and emotional support to their students, including telling their children to be happy, suggesting that they do something they love, and encouraging self-care as they pursue their engineering degrees.

Abbreviations

HBCU: Historically Black College/University; HSI: Hispanic-serving Institution; PWI: Predominantly White Institution; STEM: Science, Technology, Engineering, and Mathematics; URM: Underrepresented minority

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Authors' contributions

All authors were involved in the methodological design of this research, including its research questions and approach. CS, EP, JM, GK, and RC led the design of the interview protocols, while CS and RC conducted the interviews. EP and RC did the initial coding of the interviews, JM did a second round of coding, and CS entered the coded transcripts into the qualitative software program. CS, EP, JM, GK, and RC led the analysis of interviews generally, while EP and JM led the analysis for parts specifically included in this article. CS, EP, JM, GK, and RC led the writing of this article, and all authors agree to its publication.

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This research was reviewed and approved by the University of South Florida institutional review board. Written informed consent was obtained from participants prior to interviews, and permission to audio-record was sought before recording interviews.

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Competing interests

None of the authors share any competing interests.

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