Exploring the Effects of a Targeted Program on Engineering-Related Social Capital

Introduction

This work in progress paper explores a subset of initial data from a scholarship program that incorporates mentoring and other aspects designed to expand students' social capital via social network expansion. The larger project follows the students involved in this project to understand how students who enter the university with different levels of preparation navigate through their college careers through a social capital lens, focusing on their networks, and sense of identity and belonging within engineering. As part of the program, students are expected to meet with faculty and peer mentors, broadening the pool of potential contacts they might turn to when faced with an engineering decision. After the first two years of the program, this paper explores the experiences of nine students to understand how their social networks have changed via the Name and Resource Generator instrument, an instrument that is designed to understand student networks and access to engineering-related social capital via self-reported networks. This paper reviews the findings from the subset of longitudinal data to add to the literature related to this instrument and to gather feedback related to future directions for this project.

Background

The Campbell University's School of Engineering is able to offer students need-based scholarships through an NSF S-STEM grant. As part of this program, students are expected to take part in a variety of professional development activities including faculty and peer mentoring, industry tours, tutoring, and internship preparation assistance. This institution is located in a rural area with many first-generation college students in the engineering student population. The institution also accepts many students into the engineering program who may need an additional semester or two of preparatory mathematics before they are able to take part in the fundamentals of engineering course that is a first-year, first-semester course for students who are enrolled in mathematics course of pre-calculus or higher. These populations of students are likely to have low social capital or pre-existing networks in areas that would support their college experience [1]. Therefore, the peer and faculty mentoring and cross-cohort socialization have been integrated into the program as ways to help expand the social capital of students who may need it.

Social Capital is the availability, accessibility, and activation of resources via social relationships according to Lin [1]. While overarching societal structures encompassing demographic characteristics, family and community resources, and other factors contribute to the social capital of an individual, an individual may expand their social capital beyond these factors through their own actions [1]. Social capital is accessed via social networks. Social networks are often analyzed using Social Network Analysis to determine links between actors within a given population [2]. There are a number of methods for tracking changes in social networks over time, from assuming a static social network that is activated differently at different timepoints [3], assuming sequentially dependent changes [4], reviewing snapshots over time periods [5], and analyzing how dynamic the network is, among others [3]. Rather than seeking to explore the mathematical changes of networks, this study uses a social capital lens to investigate the changes in a subset of students' social networks, those they identify as pertaining to their educational and career success, or in other words, their engineering-related social capital.

This project is focused on understanding the student pathways through this self-styled school of opportunity, a new engineering institution that has pathways for students who are underprepared in mathematics to begin as engineering students. The overall research-focused objective for this project is to investigate the experiences of students on multiple pathways to better understand the factors that contribute to their academic success, degree persistence, and engineering employment. The specific research questions for the overall project are 1. How does participation in the program influence students' social capital related to pursuing an undergraduate engineering degree and career opportunities? and 2. In what ways do students on different pathways to engineering baccalaureate success gain awareness of, access to, and actively pursue social capital in making decisions to persist in engineering studies and forming career plans?

This work in progress paper explores a subset of data, specifically those students who were involved in and have complete data available from the first two years of the program. This paper mainly speaks to the first research question posed by the project, exploring the question: How have students' engineering-related social networks changed over time?

Methods

This is a small-n mixed-methods study. Student responses to the Name and Resource Generator (NRG) instrument and subsequent interviews were tracked across two years. Results from the NRG data are triangulated with the results from the interviews to gain a more in-depth understanding of changes in student social capital via the social networks they use to make engineering decisions and their perceptions of changes in their social networks [6].

Name and Resource Generator

This study uses the Name and Resource Generator (NRG) instrument to quantify how students' engineering-related social networks have changed during their year involved in the scholarship program. In the first section of the NRG, students are asked to provide up to eight names of individuals or "alters" who have been influential in the participants' college and career success [7, 8]. Alters are the people within a social network that can provide an individual with access to resources [1]. This instrument focuses on engineering-related social capital, the network of people that a participant feels has contributed to their engineering decisions, rather than evaluating an entire social network. The second section of the NRG asks participants to identify the resources they have had access to and what general category of person provided them with this access (family, family friend, peer, teacher or employer, or other). This study focuses on the first portion of the instrument, analyzing the changes in individuals' reported alters across two years. Longitudinal analysis of responses to the NRG is a recognized gap in the literature [9]. The number of relationships and type of relationships given are quantified based on student responses to the instrument. The changes in relationships are explored both by participant and by the type of person listed as a network contact by the participants. Basic percentages and plots are used in this work-in-progress paper as the number of participants is small.

Interviews

To further understand how students' social networks have changed as part of this program, interview data will be used. Individualized semi-structured interview protocols were developed based on student responses to the NRG instrument [7]. All interview protocols asked participants

to describe their relationships with the contacts listed on the NRG instrument and had a number of questions related to the scholarship program, their social networks, and other factors. Some common questions that are of particular interest for this study include the following:

- How has your network changed over the past year, the people you go to for advice?
- Have you intentionally tried to grow your network, the people you look to for advice?
- How has your network, or the people you talk to or go to for advice, changed since starting the program?

Participant demographics

Nine students completed two years in the program and were involved in the survey and interviews. All students identified as White, with one student additionally identifying as Hispanic. Four of the students are identified as first generation college students, as defined by having no parent with a four-year college degree. Demographic data is presented in Table 1 sorted by the four college preparation pathways identified as part of the overall study, either in pre-college or college algebra as a first mathematics course (commonly considered underprepared), precalculus without transfer credits, transfer credits from high school, or a transfer student who attended either a two- or four-year institution prior to attending this institution.

Table 1. Participant demographic data sorted by preparation pathway

Pathway	Male	Female	Hispanic	First Generation	Total
(Pre-)College Algebra	1	0	0	1	1
Precalculus	1	0	0	0	1
Transfer credits (from HS)	4	2	0	3	6
Transfer student	1	0	1	0	1

Results

Name and Resource Generator

As part of the NRG, students are asked to list up to eight contacts (alters) who have been "influential to your academic and career decision making process and success". In each instance, the number of alters reported ranged from two to seven, with a mode of four. Figure 1 shows the number of alters reported each year and the total number of unique alters across the two years. For two students, the number of alters listed increased in the second year. Four students listed fewer alters in the second year, and three participants listed the same number each year. The number of unique alters shows that three students did not have different contacts over the two years; Alex, Brian, and Allan do not have more unique alters than the greatest number of alters they listed in either year. For all the other six participants, the number of unique alters is greater than the number of alters they have reported in either year, showing a replacement of one alter with another. All students have at least two alters appearing in both years, indicating a core of consistent alters, or strong ties within their network. Most of the participants in this study also have alters that are replaced by new alters in the second year, or weak ties within their network.
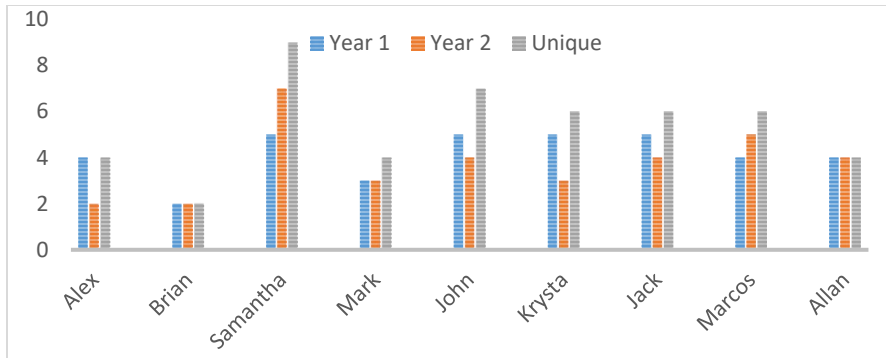
Figure 1. Named contacts from each participant each year and total number of unique contacts

In each year, nearly 50% of the relationships noted were family relationships. Of the 33 family relationships, thirty (91%) were the same alter appearing in the network both years of the study (or fifteen unique alters). This is contrasted with the faculty alters, which were volatile. Of the 24 faculty alters listed, only 33% were the same alter in one network over both years of the study. Faculty A and Faculty D were each listed both years by two different students; Faculty A is an advisor to many of the first and second year students while Faculty D is a first-year instructor and advisor of a popular extracurricular team, both faculty who the students are likely to come in contact with multiple times over multiple years. Alter relationships can be seen in Figure 2.
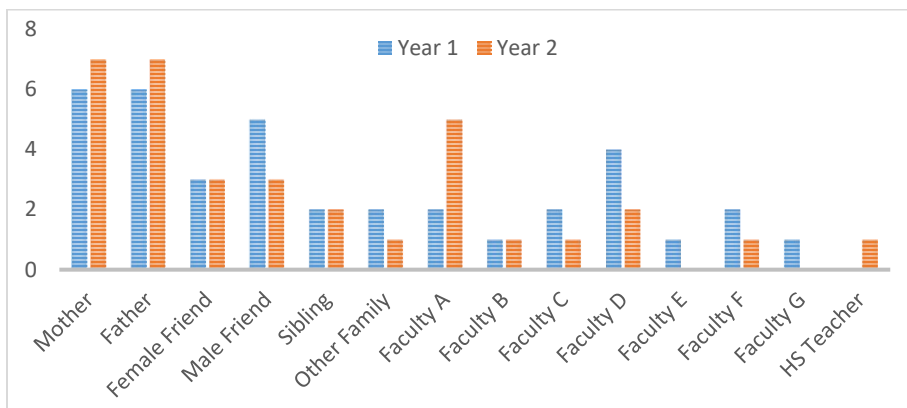

Figure 2. Alters reported by relationship.

Overall, while the faculty and peer alters were more likely than family alters to change, the percentage of family, friend, and faculty alters were consistent both years of the program and the overall percentages can be seen in Figure 3.
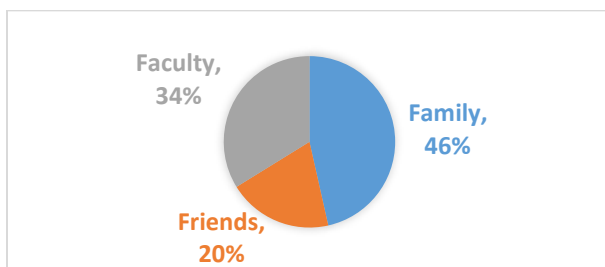

Figure 3. Distribution of alter relationships.

Interview data

None of the students described changes to their social networks since entering the program that connected to any reported changes in their NRG responses. As Alex said, "I would say it's roughly the same," when commenting on how his network has changed in the past year, though he reports no changes due to the program, "I've gotten to know some professors…but those are just small interactions at the meetings." Samantha states that "I think it's changed a little bit just because I've gotten more comfortable talking to professors in engineering."

Implications

The program is intended to help students expand their networks by providing cross-cohort socialization, peer mentoring, and faculty mentors. Based on the goals of the program, the student networks should be expanding, however only two students named more contacts in the second year than in the first and four named fewer. This may be compounded by the global pandemic; the second round of interviews was done after the students had gone home early and were taking classes virtually.

This initial subset of data seems to indicate that the program is not expanding student networks and providing them access to additional social capital. Student networks are altering, though from this data it is unclear whether the changes can be attributed to the program or are commonly seen changes. The data points toward a strong network, generally composed of family and friends, and a weak network, generally composed of current faculty mentors, advisors, or instructors of current classes, similar to that found in prior work [10, 11].

Students do not seem to be aware of the changes in their networks over the past year. Strong, long-term ties, like family, are likely to remain. Short-term ties, like faculty they have met since starting their engineering degree, may change, substituting one engineering faculty for another. This suggests that students may be going to "an engineering professor" as a general category and are not as concerned about which specific engineering professor they are seeking assistance from. This seems to be a transient role that has aspects of strong and weak ties, an alter who a student might interact with often (a strong tie) but have met fairly recently (a weak tie) [12]. The contribution of this paper to the broader literature for the NRG and engineering education literature is identifying the changing alters in the "weak ties" category and the participant's perceptions that their network did not change, even when different alters were reported.

Future work

Future directions for this work include expansion of the overall analysis to include all school of engineering participants. Quantitative work will explore the data more in-depth, similar to the analyses done by Martin et al. and Miller et al. to compare this student population with the clusters found in prior studies [11, 10]. Additional longitudinal analysis of students from this cohort who have continued in the program for a third year and students who joined in the second year and have remained through the third year will add to this longitudinal analysis to support the identification of trends. Particular areas of interest are social network access and how students conceive of the different possible categories of contacts they list in the NRG. For example, whether there is a specific category of transient alters and how students view these changing links in their networks will be incorporated in interview protocols. Future years of data collection will be able to address this new question: How did the pandemic affect student social capital?

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