



Student Relationships: A Social Network Analysis

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Lasting Impacts of a Summer Bridge and Outdoor Experience Program on Student Relationships: A Social Network Analysis

Abstract

In this Complete Research paper, we present a social network analysis of an academic summer bridge and outdoor experience program designed to support the social and academic integration of incoming STEM majors at Boise State University. Summer bridge programs can support students through both the development of academic skills and the creation of intentional community and peer support networks which can facilitate students' sense of belonging in both their chosen major and at the university. Alumni from the past five years of the program received a survey asking them to indicate their connections to other participants, faculty, and staff associated with the program. Preliminary results of this analysis suggest that the program supports the development of lasting relationships with peers, and participants continue to value and maintain these relationships well beyond the time spent together in the summer bridge program. The data also illustrate the important role that faculty and peer mentors play in facilitating cross-cohort connections, and how programmatic decisions can affect the lasting impacts of summer bridge programs.

Introduction

Motivation and Background

First-time, first-year students' transitions to university can be challenging for many reasons stemming from increased independence and leaving behind existing networks of support while simultaneously engaging in the formation of new peer groups and support networks. From the literature, we know that these challenges can be particularly pronounced for women, members of traditionally underrepresented minority groups, first generation students, students with high levels of financial need (such as those who are eligible for Pell grants), and non-traditional students [1]–[3]. Prior research (explored in more depth in the literature review section of this paper) has also shown that peer networks can provide crucial support to the aforementioned students, and play an important role in the success of all incoming students.

To address the previously mentioned challenges, Boise State University developed a summer bridge program, RAISE, that combines an on-campus component with a multi-day outdoor experience (See [4] for more background on this program). The on-campus portion of the program focuses on relationship-building among STEM students, building skills and awareness of campus resources for academic success, structured interactions with faculty, and social events designed to promote connection, belonging, and academic success at the university [4]. An intentional aspect of the program is the involvement of peer mentors who are STEM students already at Boise State University, many of whom are former participants of the bridge program. Students stay together on campus in university housing and begin to build community through evening social events. These newly developed relationships are then strengthened through shared experiences camping, rafting, hiking, and exploring STEM activities in the outdoors. This

combination of activities helps students transition to their first semester at the university with relationships with peers, mentors, faculty, and staff who can support their success and persistence in their STEM degree programs.

To measure the lasting effects of these programs, we conducted a social network analysis of participants from the past five years of this program. Social network analysis provides a powerful research method for understanding relationships within a community, and how members of a community are connected to each other. Participants completed a survey exploring the number and strength of the relationships that they have maintained with their peers who also participated in the program. The survey also allowed students to identify connections with peers who started in different academic years than they did.

In this paper, we will give a brief background of the program (as mentioned above, see [4] for more details), and then will discuss our social network analysis and results from that analysis. We will conclude with future directions for this research.

RAISE Program History and Structure

RAISE (Recreation and Academics in a Summer Experience) is a week-long summer bridge program for incoming first-year STEM students at Boise State University. While RAISE is open to all incoming first-year STEM students, the program specifically recruits students who are from underrepresented minority populations, who are the first in their family to attend college, identify as women, and/or who have high levels of financial need. The form and length of the program has evolved over the past few years (See Table 1), but is currently linked with a mid-summer new student orientation, creating an extended orientation experience for most participants (participation in the linked new-student orientation is not required). Students spend a total of four nights on campus in a residence hall, followed by a three-day rafting and camping trip on a river that is about 2 hours from the university. The structure and activities of the program were described in more detail in the previous ASEE paper [4] mentioned above. The RAISE program is also a required component of an NSF S-STEM scholarship program, which is a part of the Redshirting in Engineering consortium [5].

RAISE offers students the unique experience of building a diverse STEM community. Program learning outcomes include:

- helping students establish new relationships with other incoming STEM students, and enhancing students' feelings of social belonging through peer mentoring
- fostering faculty interaction
- acclimating students to the campus environment
- helping students develop study and life skills to support academic goals and persistence through their first year and beyond

Table 1. Overview of Program Changes By Year

Program Year	Overview of Program Structure	Notable Changes/Circumstances
2015	STEM Summer Adventure (outdoor program) and LSAMP Bridge Day (on-campus program) were separate programs (data shown here only reflect participants in STEM Summer Adventure)	
2016	STEM Summer Adventure and LSAMP Bridge Day were separate programs (data shown here only reflect participants in STEM Summer Adventure)	
2017	STEM Summer Adventure (4 days) and Bridge to Boise State program (3 days) were combined into one program, though participants could choose to only participate in either part, included peer mentors as part of on-campus program, and increased the recruitment of URM and female students due to the integration with the goals of a new S-STEM award	First year of combined program, program took place during the week before the fall semester started, first year of associated S-STEM program, all S-STEM scholarship recipients enrolled in same classes during fall and spring of their first year
2018	RAISE program included On-Campus Experience (2.5 days) and Outdoor Experience (3 days), included peer mentors in both parts of the program, during on-campus program, participants were assigned to a specific peer mentor as part of a “family group”, intentionally recruited high percentage of URM and female students, program cost subsidized by private donor	Program was moved to mid-summer and paired with a New Student Orientation, second year of associated S-STEM program, all S-STEM scholarship recipients enrolled in same classes during fall and spring of their first year
2019	RAISE program included On-Campus Experience (2.5 days) and Outdoor Experience (3 days), included peer mentors in both parts of the program, during on-campus program, participants were assigned to a specific peer mentor as part of a “family group”, intentionally recruited high percentage of URM and female students, program cost subsidized by private donor	Program structure similar to previous year, including continued sponsorship of the program by corporate foundation, change in S-STEM program course structure (students involved in CAMP or LLP only took one of two fall program courses)

Literature Review

Importance of Belonging and Impact of Summer Bridge Programs

First-year students endure a number of life experiences that make the transition to college uniquely challenging, including financial concerns, adapting to more rigorous coursework, finding and adapting to a new peer group, and leaving behind family and friends [4]. One factor which has been shown to help students through this transition is a sense of belonging, and links have been shown between summer bridge programs and increasing this sense of belonging [6]. Summer bridge programs have been shown to be an effective practice for decreasing attrition in STEM students, especially URM students [7].

Mentoring and Peer Networks

A student's level of involvement in both the academic and social realms of college can mean the difference between staying in college and leaving [8]. Research clearly outlines that a student's interaction with their peers, faculty and staff is one of the strongest predictors of persistence [8], [9]. Moreover, peer and faculty mentoring can positively impact academic success and undergraduate development [10]. Mentoring is recommended as a central student success strategy in STEM undergraduate education [8], [10], [11], [14]. Mentoring efforts are positively linked to several academic outcomes such as increased academic performance, higher GPAs, degree attainment, persistence, and retention. Over a decade of research highlights the ways faculty, staff, graduate students, and peers make significant contributions to a student's social and academic adjustment to college [11], [12]. Also, work done by Hryciw, Tangalakis, Supple, and Best found peer mentoring to be beneficial for both mentees and mentors [13].

Faculty mentors are uniquely positioned to help students navigate the sometimes confusing landscape of higher education, as well as expand a student's personal and professional networks, and provide validation and critical feedback on their academic progress. For these reasons, faculty and student interactions are critical to the undergraduate student experience. Additional studies done by Crisp and Cruz have found that mentoring can help with student persistence in college and overall adjustment [14].

Impact on Underrepresented Students

Several studies indicate the critical role mentoring and social support networks play specifically in the educational progress of students from racial and ethnic groups who have been traditionally underrepresented in the STEM fields [15], [16]. Studies have demonstrated that mentoring can lead to higher grade point averages, increased self-efficacy, more clearly defined academic goals, and lower attrition for students from underrepresented backgrounds [15], [17]. Studies done by Kendricks and Arment found mentoring initiatives fostered a nurturing environment for underrepresented minority STEM students and that students reported feeling comfortable, safe and supported by their mentors [18]. For students from traditionally underrepresented backgrounds, social support is essential for their continued success at the university [19].

Methods

Our goal for this study was to understand the lasting effects of participation in RAISE and previous summer bridge programs at Boise State University, and how these programs influence students' sense of belonging and connectedness. To address these goals, we utilized Social Network Analysis (SNA), a useful tool for capturing relationships among social entities, and identifying patterns within these relationships [20]. SNA is a well established tool in social science research and has been used in prior studies of engineering and computer science education. These studies have focused on the role of race and gender in the social structure of a first-year engineering course [21], the effects of computer supported collaborative learning [22], group decision making dynamics [23], and distributed cognition and collaborative learning [24].

Data Collection

We collected social network data using a Qualtrics online survey modified from one we developed for a previous project to understand students' connections and sense of belonging within a single major at the university [25], which is included as Appendix 1. The survey asked the respondents to indicate up to ten people associated with the program who they felt most connected to, including peers, faculty, and staff associated with the program. We obtained the respondents' demographic information from university records, including race/ethnicity, gender, year of participation in RAISE, and university major. All former participants in either the on-campus or outdoor programs (N=123) received a link to participate in the survey, of these n=40 students responded - yielding an overall response rate of 32.5%. Respondents received five dollars to incentivize participation.

Data Analysis

After exporting and cleaning the data, we utilized the igraph package [26] in R for analysis, and the visNetwork package [27] to render the resulting social networks. To explore patterns in the data, we generated multiple visualizations of the data using colors and shapes to indicate the respondents' demographic characteristics. We used the resulting sociograms to gain insights into the role that year of participation, gender, URM (from a traditionally underrepresented minority population by NSF LSAMP definition [28]) status, and university major played in the students' social networks.

Results

Table 2 shows the number of participants and respondents by year of the program, which ranged from 16 to 37 participants. There is large variation in the response rates by year of participation, with rates tending to drop as the time from participating in the program increased. Table 3 summarizes the gender of participants. These data are shown in the sociograms in Figures 1 and 2, where Figure 1 shows only those participants explicitly mentioned by a survey respondent, while Figure 2 shows all participants in the program grouped and colored by year of participation. In these and all subsequent graphs, darker colors indicate the survey respondents and lighter colors indicate individuals who were present in the program but did not complete the

survey. Shapes indicate a combination of gender and role in the program, including participant, peer mentor, and program staff (defined in the legend in each graph).

Table 2. Participants in the program by year

Year	Participants	Responses	Rate
2015	34	5	14.7%
2016	26	5	19.2%
2017	16	3	18.8%
2018	21	7	33.3%
2019	26	14	53.8%

Table 3. Gender of participants in the program

Gender	Count
Male	72
Female	56

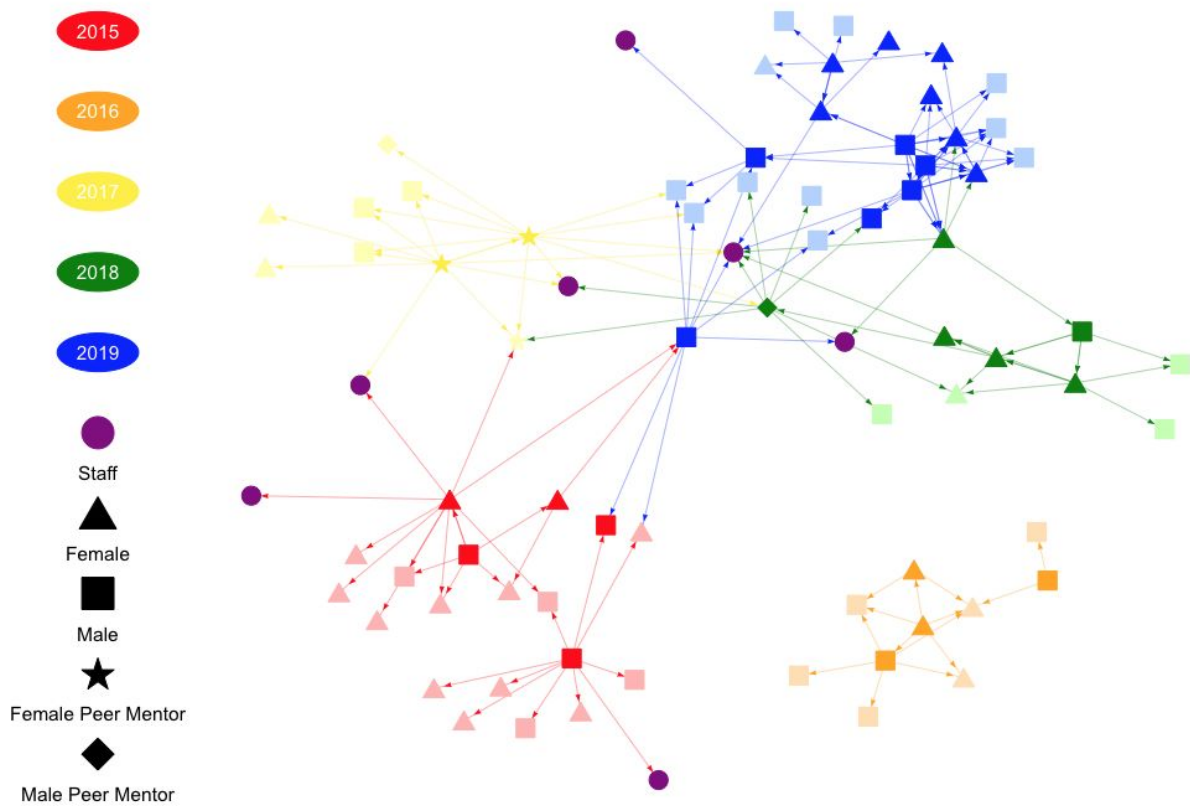


Figure 1. Network showing only individuals explicitly mentioned in the survey. Darker colors indicate survey respondents.

Figure 2 demonstrates several notable trends in the data. With minimal structured programming following the summer outdoor experience, the students in the 2015 and 2016 cohorts are completely disconnected from the other participants in the program, whereas subsequent cohorts included both peer mentors and required followup classes which may serve to increase cross-cohort connections. It also demonstrates the important role that the individual responsible for teaching these classes and overall administration of the S-STEM program (the well connected purple dot at the center of the network) plays in enabling these cross-cohort connections. While likely affected by variations in the response rate to the survey, which may itself be indicative of the diminishing importance of the program to students over time, Figure 2 also shows the students who most recently completed the program and are still enrolled in the follow-up class are much more connected than other cohorts.

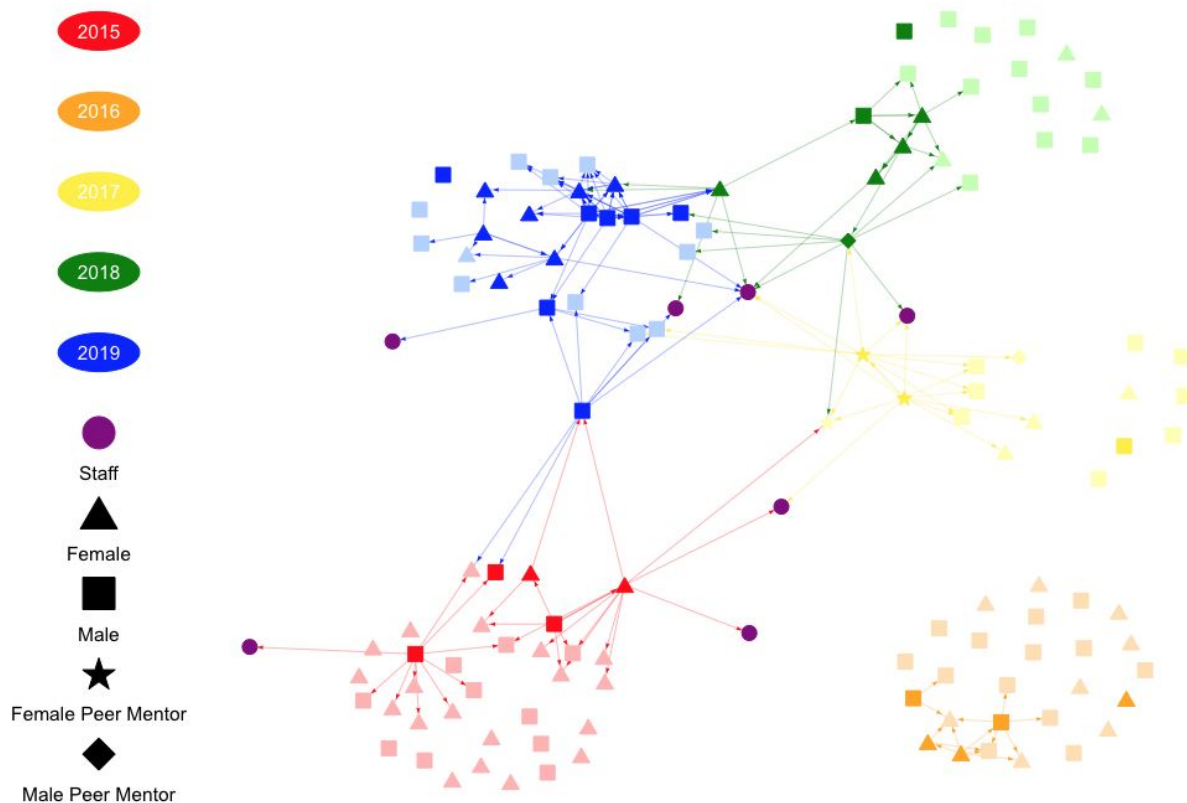


Figure 2. Complete network with color indicating year of participation.

Table 4 reports the race and ethnicity of all students who participated in the program. As described earlier, in 2017 the program shifted to more explicitly recruit and support underrepresented students in conjunction with the new S-STEM scholarship program, resulting in significantly higher participation rates for these students compared to their overall representation at the university [4].

Figure 3 shows the same connection data as Figure 2, but with color corresponding to the participants underrepresented minority status. This visually displays the shift in the program to focus explicitly on recruiting and supporting underrepresented students, and also demonstrates some clear cross-cohort linkages facilitated by URM students. Examining the group in the upper left corner of this graph, corresponding as in Figure 2 to the 2019 participants in the program, we see what appears to be distinct and separate networks of URM (red) and Non-URM (blue students). This may be at least partially attributable to a policy decision in an associated NSF S-STEM program (for which attendance at RAISE is a requirement) where students involved in other university support programs (an engineering living-learning community and the College Assistance for Migrants Program on campus) were not required to take a supplemental seminar, since those programs have seminars that cover similar topics (academic success strategies, career exploration and preparation). Since most of the URM students in the S-STEM program were in one or both of these support programs, this policy change had the unforeseen consequence that the enrollment in the supplemental seminar was primarily composed of non-URM students. While all participants in the S-STEM program were enrolled in an additional course besides the supplemental seminar, this extra class meeting each week may have led to the formation of more social bonds between the students in the supplemental seminar.

Table 4. Ethnicity of participants in the program and Fall 2019 University-wide undergraduates

Ethnicity	Count	%	Count at University	% of University
White	76	59.4%	12,440	73.6%
Hispanics of any race	32	25.0%	2,314	13.7%
Two or more races	8	6.3%	858	5.1%
Asian	4	3.1%	430	2.5%
American Indian/Alaska Native	1	0.8%	58	0.3%
Black/African American	2	1.6%	278	1.6%
Native Hawaiian/Other Pacific Islander	0	0.0%	79	0.5%
Nonresident Alien	0	0.0%	189	1.1%
Race and Ethnicity unknown	0	0.0%	252	1.5%
Non-URM	82	66.7%	13,408	79.3%
URM	41	33.3%	3,301	19.5%
International	0	0.0%	189	1.1%

NOTE: University numbers given are for degree-seeking undergraduates as of October 15, 2019.

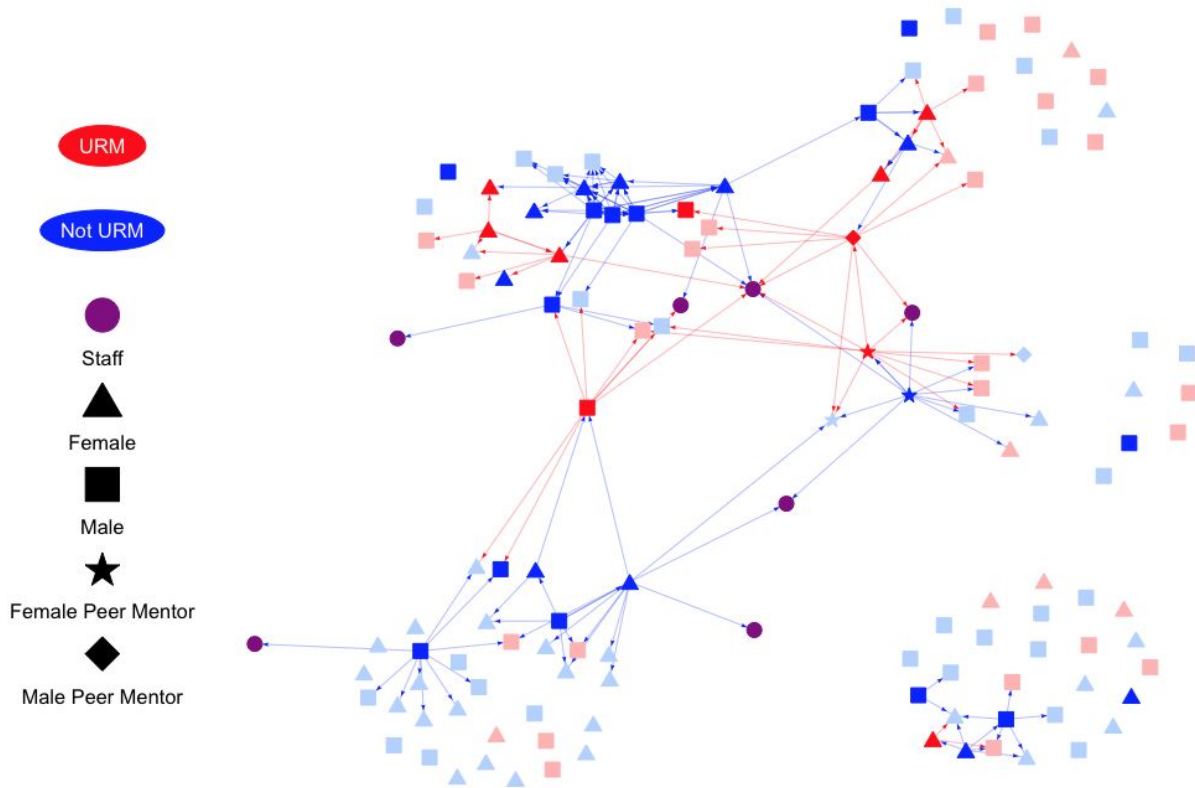


Figure 3. Complete network with color indicating URM status

Table 5 and Figure 4 present the variation in the current academic majors of participants in this program. Computer science is the most highly represented major, while engineering is the most highly represented major grouping in the program. STEM degree classification is based on the NSF LSAMP (National Science Foundation, Louis Stokes Alliance for Minority Participation) Classification of Instructional Programs (CIP) [29].

Figure 4 shows that a significant majority of the participants in RAISE in the last three years were engineering or Computer Science majors. This is largely attributable to the fact that RAISE is a required element of an NSF S-STEM program in the College of Engineering, which includes subsequent cohort-building through organized social activities and shared courses. It is also worth noting that the programs described in this paper have consistently been marketed exclusively to those students indicating a STEM major at the time of enrollment at the university, so participants currently enrolled in non-STEM degree programs transitioned to these majors after participating in the program. Overall, the data indicate that while this summer bridge and transition program do support some interdisciplinary connections, the lasting connections from these experiences seem to have the most significant effect on engineering students.

Table 5. Majors of participants in the program as of the Fall 2019 semester

<u>STEM Major</u>	<u>Count</u>	<u>Non-STEM Major</u>	<u>Count</u>
Computer Science BS*	26	Health Studies BS	5
Mechanical Engineering BS*	24	Construction Mgmt BS	3
Civil Engineering BS*	13	Political Science BS	2
Electrical Engineering BS*	9	Pre-Business	2
Materials Science & Engr BS*	8	Games Interactive Media Mobile	2
Biology BS	7	Global Studies BA	1
Geosciences BS	4	Interdisciplinary Studies BA	1
Engineering BS*	3	Anthropology BS	1
Applied Mathematics BS	2	Pre-Criminal Justice	1
Mathematics BS	2	Kinesiology BS	1
Engineering Undeclared*	2	General-Undeclared	1
Chemistry BS	1		
Environmental Studies BA	1		
Information Tech Mgmt BBA	1		

*Indicates majors eligible for scholarships through an NSF S-STEM award for engineering and Computer Science students.

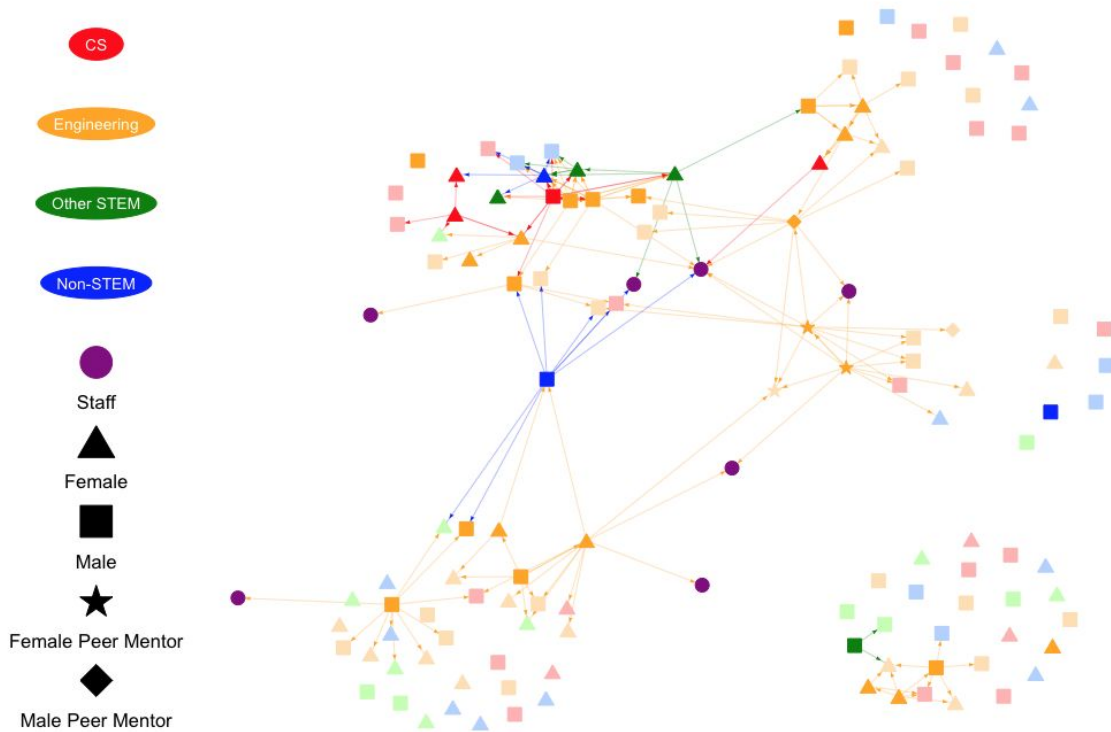


Figure 4. Complete network with colors indicating major.

Conclusions and Future Work

The social network analyses in the above sections indicate that the summer bridge and transition program supports continued connections between the participants, especially when those connections are supported through an ongoing NSF-supported program that includes a course and a staff member charged with mentoring the students.

Due to the evolving nature of both the summer program and the related NSF scholars program, it is hard to reach definitive conclusions about the impact of the summer program, independent from these other factors. Therefore, the next step for this research team is to continue to follow upcoming cohorts (who will attend the program in summer 2020) through their university studies.

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Appendix 1: Qualtrics Survey Used to Collect Social Network Data

Q1 The primary purpose of this survey is to understand how you are connected to other students and mentors who participated in the RAISE/SSA program at Boise State University. In the spaces below, please indicate the ten individuals who participated in this program that you feel most connected to by typing their names in the spaces below, and indicate how you interact with each person by checking all of the appropriate boxes. As you type, the text box will automatically provide you a list of matching individuals to choose from.

Name	How often do you interact with this person?				How do you interact with this person?		
	A few times a semester	Once a week or so	Multiple time a week	Pretty much everyday	In class	In person outside of class	Electronically
1. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. <input type="text"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Q2 The following list is associated with traditional or non-traditional student status. Please click to select all items in this list that apply to you.

- You waited until you completed graduation from high school before enrolling in postsecondary education.
- You attend postsecondary education part time, at least one semester of the year.
- You work 35-hours or more per week while enrolled in postsecondary education.
- You consider yourself independent for purposes of determining eligibility for financial aid.
- You have dependents other than a spouse (i.e., children, sick or elderly family members).
- You are a single parent (i.e., not married, married but separated, and with dependents).
- You have a GED or other high school equivalency diploma, or did not complete high school.

Q3 Where do you live?

- I live on campus
- I live off campus, but walk or bike to school
- I live off campus but commute to school by car or public transit

Q4 Do you feel like you belong in your major at Boise State University? Why or why not?