



How Underrepresented Minority Engineering Students Derive a Sense of Belonging from Engineering

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Abstract

While feeling overwhelmed by the workload, pace and conceptual difficulties can be a common experience among undergraduate engineering students, ethnic minority engineering students often face additional challenges in their undergraduate programs, which can make them feel isolated and hinder their ability to integrate into their college campuses. Integration into the college environment plays an important role in students feeling a sense of belonging on campus, and ultimately in their decisions to persist. Racial and ethnic minority students who are integrated into the college environment through various means can find supports such as friends with similar backgrounds, advice from advanced students, and role models and advisors, which can positively influence academic performance. This paper identifies four main areas which under-represented minority students in engineering described as helpful to their development of a sense of community and belonging: co-curricular/extracurricular involvement, peer support, faculty and department support, and residence programs. The study demonstrates that under-represented minority engineering students were able to derive a sense of integration, community and belonging using multiple means, and that the support mechanisms they used changed a bit over time. By understanding the different ways that under-represented minorities are able to integrate into their college campuses and ultimately find a sense of community and belonging, engineering programs can work to develop strategies to better support under-represented minority students in their programs, potentially contributing to student persistence and retention.

Introduction

Feeling overwhelmed by the workload, pace and conceptual difficulties can be a common experience among undergraduate engineering students.¹ Ethnic minority students may face additional challenges, such as differences in ethnic/cultural values and socialization, internalization of negative stereotypes, ethnic isolation and perceptions of racism, and/or inadequate program support.^{1,2} Further, due to typically small numbers of minority students and faculty in engineering programs, students may lack peers, faculty role models and mentors.¹

Feelings of difference can result in students lacking a sense of belonging, which can influence confidence in completing an engineering degree.^{2,3} Students' social integration into the college environment, such as their relationships with peers, can influence their ability to establish and access support networks, and can contribute to persistence in engineering programs.²⁻⁶ Racial and ethnic minority students who are integrated into the college environment through various means can find supports such as friends with similar backgrounds, advice from advanced students, and role models and advisors, which can positively influence academic performance.^{4,7,8}

This qualitative analysis offers important insights into the sense of belonging of African American, Latino, and American Indian students in undergraduate engineering programs, which can contribute to improved support, retention and ultimately, increased graduation rates for these students. Specifically, the study answers the following research questions: 1) What are the

different ways that under-represented minority engineering students find a sense of belonging at engineering schools; and 2) How might these contribute to their ability to persist? To answer these questions, interviews with thirty-seven underrepresented minority engineering undergraduates were analyzed. What follows is an examination of some extant research focused on issues and challenges specific to under-represented minority engineering undergraduates, how a sense of belonging relates to persistence in college, the role of social and academic integration in developing a sense of belonging, and some ways that under-represented minorities are achieving social and academic integration into the college environment. Next, we describe the research methods used for the study, the study findings, and concluding thoughts and implications.

Literature Review

Issues and Challenges Specific to Under-represented Minority Engineering Students

Many students of color face challenges as a result of being under-represented minorities in engineering undergraduate programs. They may deal with differences in cultural values and socialization, stereotypes, isolation, perceptions of racism and inadequate program support^{2,9}, and they may lack peers, faculty role models and mentors.¹ Many students experience feeling different as they adapt to new and different communities; and peers may, intentionally or not, emphasize these differences by pointing out their race.^{2,9}

Students' self-confidence may be undermined by perceptions that white faculty and students see them as having inferior abilities.¹ In fact, minority students often report that they feel like faculty have lower expectations for them than for other students⁸, and they may even receive lower grades as a result.⁹ This may be exacerbated by the fact that minority engineering students are less likely to interact with faculty than non-minority students.⁸ In addition, engineering departments often lack minority engineering faculty; therefore, minority students frequently miss out on the benefits of having role models with similar ethnic and cultural backgrounds.⁸

Students who feel uncomfortable in engineering environments may experience difficulty seeking the kind of support from faculty and/or students that could contribute to their academic performance.² They also may feel like these supports are inaccessible. For example, Seymour & Hewitt found that the Black students in their study viewed faculty as unapproachable and felt excluded from student study groups.¹ When Latino students experience feelings of alienation, it can negatively impact their self-concept, as well as their academic and social adjustment to campus life, which ultimately can have direct effects on both their learning and social outcomes.⁴ Students who feel different from the majority, and perhaps even socially stigmatized, feel less certain of the quality of their social bonds, and ultimately more sensitive to issues of social belonging.^{2,9} Uncertainty about students' belonging may lead to students believing that *people like me do not belong here*.⁹ While a lack of social connections may seem like a minor issue with regard to students' academic success, experiences that threaten a person's social connectedness can have great effects on student motivation to persist.⁹

Sense of Belonging and Persistence in Education

Social belonging, or seeing oneself as socially connected, acts as a basic human motivation, which can contribute to more favorable outcomes.⁹ A sense of belonging can be defined as a

student's psychological sense of identification and affiliation with the campus community.¹⁰ Students' beliefs about belonging have been associated with confidence in completing an engineering degree, whereas a lack of belonging in engineering can be an important factor in students' decisions to leave undergraduate engineering programs.³ How students perceive themselves, along with how they believe others perceive them, impacts both their sense of belonging and feelings of difference in their academic environment.² In fact, while many students successfully engage in their academic contexts, their social identities in the academic context are often characterized by feelings of difference and lack of sense of belonging.² Therefore, although a sense of belonging operates as a belief held by students, external factors, such as student interactions with faculty and peers, contribute to this belief.³

Social Integration and Sense of Belonging

Social and academic integration of college students has been found to contribute to student retention.¹¹ Formal and informal aspects of social life, including co-curricular activities and other personal interactions on campus, as well as formal and informal aspects of academic life, such as faculty-student learning interactions in and out of class, respectively influence social and academic integration.^{11,12} These factors also influence students' sense of belonging on college campuses, which can increase student commitment, and ultimately student persistence.^{5,9-13} Student commitment to an institution, whereby they like it, feel comfortable in it, and are satisfied with their academic and social development, stems from their satisfaction with the college experience.¹³

Racial and Ethnic Minority Student Integration into the College Environment

Research suggests that peer and faculty support, as well as co-curricular involvement, play important roles in creating supportive educational environments, which can contribute to the retention of minority undergraduate engineering students.^{2,4,12} Such supports include minority and/or female role models and advisors, advice from upperclassmen from similar ethnic groups and minority relations staff.⁴

Some minority students find it difficult to form and participate in study groups due to their racial and ethnic differences.² Further, participation in formal peer networks, such as under-represented academic student organizations, or a lack thereof, can influence a student's sense of community.^{2,13} Through co-curricular involvement, students have opportunities to foster relationships with friends who have similar cultural and socioeconomic backgrounds, which can provide a caring and supportive educational community.⁴ Many students indicate that a distinction exists between their academic and social peer groups.² Whereas, academic peer groups tend to reflect the majority represented in the engineering program, social groups generally reflect personal ethnicities.² Social peer groups not only address cultural needs, but also meet personal needs, such as opportunities for relaxation and reflection.^{2,4} In other words, minority students often maintain separate academic and social peer networks, both of which play important roles in student persistence, for distinct reasons.² For example, ethnic organizations and residences contribute to maintaining ties to cultural heritage, while academic networks help facilitate academic achievement.² Regardless of which network peers fall into, they serve as important supports for students.²

Students of color, particularly women, express a desire to be included in their academic communities; and they want mentors, faculty and alumni to provide guidance and share their experiences with them.² These faculty and alumni, as well as staff members, can serve as role models who have successfully navigated the educational system.⁴ When students have opportunities to interact with faculty, and/or attend a college with student-centered faculty, this can contribute both to their college adjustment and their success in college.⁴ In fact, the academic achievement of Latino students in particular tends to be enhanced by professors perceived to be supportive and accessible.⁴

Students' level of comfort approaching faculty for academic and social support can contribute to their sense of belonging.³ Students who cultivate relationships with faculty members outside the classroom tend to both report higher levels of satisfaction with their college and graduate.⁴ In fact, minority students who complete science and engineering degrees often highlight the role of a faculty member as being instrumental to their success.⁴ Positive experiences with supportive faculty can increase students' sense of belonging and contribute to a climate that welcomes difference.² In fact, positive interpretations of campus climate tend to be created through faculty member support, intellectual challenge and encouragement.⁴ Interestingly, students who feel a sense of belonging tend to view faculty interactions more positively, which is related to higher GPA and greater chances of program completion.³

Existing literature regarding student success in undergraduate engineering programs does not offer a lot of insight into the specific experiences of under-represented minority men and women. This is particularly true with regard to what influences students' sense of belonging and persistence in such programs. In fact, some quantitative studies that intended to examine perceptions and beliefs of various underrepresented minority groups could not offer significant results, or could only offer limited results, due to the low number of participants from these groups.^{3,5, 23, 24} This qualitative study addresses some of these literature gaps by examining underrepresented minority student perceptions of what helps them derive a sense of belonging, and how these contribute to their ability to persist.

Research Methods

This qualitative inquiry, which is part of a larger mixed methods research project funded by the Alfred P. Sloan Foundation, known as the Project to Assess Climate in Engineering (PACE), focuses on making sense of the realities and experiences of undergraduate engineering students and thus incorporates an interpretive perspective.¹⁴ Qualitative interview approaches have been successful in elucidating the perspectives of STEM students from underrepresented groups.¹⁵⁻¹⁷

This paper seeks to answer the following research questions: 1) What are the different ways that under-represented minority engineering students find a sense of belonging at engineering schools; and 2) How might these contribute to their ability to persist? Given the focus of this study, the settings are 11 US universities, with engineering enrollment between 945 and 5500 students, and with average enrollment of 3062 engineering students. Seventy-three percent are public universities, fifty-five percent are designated "very high research activity" under the Carnegie Classification, and 27 percent are Minority-Serving Institutions. Unlike other research^{3,5}, this sample includes a diverse group of respondents. Students were selected to

participate based on a stratified random sample of currently enrolled engineering majors 18 years of age or older.

Semi-structured interviews were conducted with participants from the spring of 2008 to the spring of 2009 to gain an understanding of student experiences in their own words, allowing the researchers and participants to engage in *conversations with purpose*.¹⁴ One-on-one interviews were conducted and audio-recorded at each participating institution by trained PACE research team members and consultants. Interview questions focused on reasons for choosing an engineering major, experiences with engineering departments, support structures, and experiences specific to being an underrepresented student in engineering. An appropriate qualitative study sample size is one that sufficiently answers the research question(s).¹⁸ Therefore, this project analyzed interviews with thirty-four underrepresented minority students ranging in age from 18-28. See Tables 1-3 for demographic information about the participants.

Data analysis, using NVivo 9 qualitative data analysis software, utilized a combination of both open and focused coding methods.¹⁹ Research questions provided a lens for the notation of ideas and themes, as well as for code generation.¹⁹ This led to organizing and grouping data by theme and relationship to other data, moving from general to specific themes and vice versa, in order to understand the phenomenon being studied.²⁰ Throughout the process, we looked for patterns, themes, and regularities, along with contrasts, paradoxes and irregularities. Data displays such as matrices were enlisted for organizing and exploring the data.²¹ Various techniques, such as analytic memo writing, were used during the analytic process to help interrogate, systematically explore, and make sense of the data.²⁰

Table 1. Gender & Race/Ethnicity of Engineering Undergraduate Participants in This Study

	African American	Latino	American Indian	TOTAL
Female	5	8	1	14
Male	6	12	2	20
TOTAL	11	20	3	34

Table 2. Majors of Engineering Undergraduate Participants

Major	# of Students
Aerospace Engineering	2
Bioengineering	1
Biomedical Engineering	3
Chemical Engineering	4
Civil Engineering	1
Computer Science	1
Electrical & Computer Engineering	8
Information and Communication Tech	1
Mechanical Engineering	13

Table 3. Year in School of Engineering Undergraduate Participants

Year in School	# of Students
First	7
Second	11
Third	9
Fourth	4
Fifth	2
Sixth	1

Research Findings: Sources of Support Contributing to Students' Sense of Belonging

While the data from this study confirms findings from existing literature, it also contributes new findings that offer additional insights, from student words and perspectives, on various ways that under-represented minority engineering students seek and find a sense of belonging on their college campuses. Much like the current research, this study indicates that being part of a supportive community can contribute to under-represented minority engineering students' sense of belonging, which has the potential to contribute to their persistence in engineering undergraduate programs. Community and support can stem from a variety of sources. Students find and create supportive communities by developing relationships with peers, faculty and/or other college or department staff through orientation and college-prep programs, residence programs, cohort programs, and participating in co-curricular and/or extracurricular programs and/or activities. They also do this by seeking and offering peer support and through approaching and developing relationships with faculty and other department staff. Interestingly, our research also indicated some potential patterns across both race/ethnicity and gender regarding the types of sources of support different groups tended to develop and utilize.

Co-curricular and/or extracurricular involvement

When discussing aspects of their engineering experiences related to developing and feeling a sense of community and belonging, most student participants spoke about co-curricular and/or extracurricular involvement on campus. Co-curricular activities require a student's participation outside of normal classroom time as a condition for meeting a curricular requirement.²² Extracurricular activities refer to voluntary academic or non-academic activities that are conducted under the auspices of the school but occur outside of normal classroom time and are not part of the curriculum; and they do not involve a grade or academic credit.²² Many students talked about being involved in one or more programs and/or organizations on campus—be they professionally or academically oriented, social in nature, or serving multiple purposes. They also described reaping various benefits in terms of social and academic integration from their participation.

A number of students participated in professional societies, such as the National Society of Black Engineers (NSBE) or the Society of Hispanic Professional Engineers (SHPE), where they had opportunities to build relationships with other undergraduate engineering students, people working in the engineering field, as well as secondary students interested in engineering, all with

similar ethnic and/or cultural backgrounds. These particular groups offered opportunities to identify and develop sources of academic, social and professional support. Students talked about developing lasting peer relationships that acted as significant sources of social and/or academic support. They also described receiving meaningful guidance and support from older engineering students and sharing their experiences and knowledge with younger and/or potential engineering students.

There are three main tiers [in NSBE]: PCI, which is a Precollege Initiative, which is high school and below; and then collegiate, which is us, and in particular, undergrad; and then – oh, what’s the other term – forgot the other term, but it’s for people who are actually out in the world in industry. And you get the different worlds, you get the different perspectives because they’re trying to pull in younger kids into engineering, and even though it’s National Society of Black Engineers, there’s every race in there...So you can kind of relate on different levels, not just academically, but even socially. So it kind of brings you a little bit closer in that sense, you can get help from somebody else [who’s] done it before, or they might need your help, and so on, and so forth. And then there’s a bit of professional development, because it’s all geared toward you being a better engineer first, and then a person, and so on, and so forth.—African American Male – 6th Year (P22)

Student participation in these professional societies also provided them with networking opportunities with members through social events, such as barbecues and picnics, as well as with professional networking and development through conferences and leadership development experiences. In addition, students described gaining access, through their involvement, to various resources, such as scholarships, connections with engineers working in the field, internships and co-ops. While many students talked about these professional societies as ways for them to connect with needed supports, both social and academic, some also described how their participation gave them ways to support other students with similar ethnic and/or cultural backgrounds through tutoring and hosting secondary students interested in engineering.

Through the department, and through the [The National Organization for the Professional Advancement of Black Chemists and Chemical Engineers...we host students from sixth and seventh grade on the weekends, and they come up and do experiments through the same program that I did when I was in middle and high schools...So that’s been really fun for me to put it all in perspective, and sort of see myself in the kids who are coming in...to make sure that students are aware of the options in engineering...I think it’s just really important to make sure that students, like these sixth and seventh grade, these very young students, know that engineering is an option...So doing those experiments, and participating in that program has been really cool for me.—African American Female – 3rd Year (P9)

Some students described finding a sense of community, which they were not finding in their engineering departments, through professional societies and organizations. They explained how they met and engaged with people who could relate to their experiences and vice versa, and the importance of that to them. Not only did students describe the sense of community they often found through these professional societies, they explained that these organizations helped them and others like them feel welcome on campus.

I would say I know I'm a part of a community of electrical engineers, but I don't necessarily feel a part of the community. That's not to say I'm completely saying it's the school's fault, maybe I could have made a greater effort. But at the same time, I kind of was drawn to things that more readily relate to me. For example, with NSBE, we relate on an ethnic level; that's even a tighter bond than just our educational level. Whereas if I were to be part of Eta Kappa Nu or something like that, they'll never understand the experiences I'm having. And I'll never understand some of theirs. So it's both ways; not necessarily with the community as a whole, but also because of my choices.—African American Male – 6th Year (P22)

In addition to minority-oriented professional societies, students also described involvement with different engineering programs focused on supporting specific groups, which provided opportunities for social and academic integration. Students explained how minority engineering programs on campus provided them with both support and encouragement by bringing minority students together, as well as through their work to keep the numbers of minority students in engineering up.

There's the Society of Hispanic Professional Engineers, and there's EMSEP, which is a program that's [run] by [someone] in the campus center, and they do it with freshman students and you continue to do it as you are on campus. And what it does is it brings all the minorities together and it makes you work on different things so you can look to each other for support so you're not lost...I actually didn't [start it freshman year]. Now I talk so much about it because I encourage all of my freshman students – like the freshman group I had and other students – to join it. I joined it this year and I've been helping a lot with them...[E]verybody that's in my year that did it, I know them all. I'm friends with them. I joined it and I go to the meetings, et cetera. The support that comes out of that is great and that, I think, relates back to the engineering part and back to the course and the class. Again, you see them there, and you're able to interact and get help from them.—Latino Male – 2nd Year (P30)

Some female students explained how Women's Centers and programs on campus provided them with a place where they could feel comfortable and could interact with women and others socially or for academic purposes. Other students described how programs for economically and/or educationally challenged students provide them with ongoing support and guidance through their program.

[H]ere within [the school] they have the women's center. They already know that when it comes to [the school] itself, that there's not [many] women that attend [the school], so they also have a center where women can be comfortable. And also when it comes to ethnicity they also have clubs or organizations for people that may feel like, "Hey I think I belong in this club," "Hey, I'm Muslim. I belong in that club." Or, "Hey, I'm black, I feel I want to go in this club." And it seems like you don't have to be that sort of race, or that sort of religion. You can just go in the club just like that, so it's pretty diverse...They have ways of welcoming us, like when I first came [here], I did come to the SWE program. SWE is Society of Women Engineers...and, they're very welcoming.—African American Female – 3rd Year (P8)

Students also talked about how some of these organizations provided programs for them before college and/or when they were incoming freshman that helped orient them to engineering and college campus life, as well as connect them with faculty and various opportunities. Female

students described connecting with other women through these programs, and students described opportunities to meet and develop relationships with faculty members, as well as to work with them on research projects.

It's through the [Multicultural Engineering Programs Office], and I stayed here, on campus for four weeks during that summer, and we were introduced to different engineering faculty, and they told us about the different engineering disciplines. It was really fun; it's like simple experiments and stuff like that. And then they invited me to come back every summer between that summer and when I first started college. So I was always on the campus over the summer. And the summer after tenth grade, I was able to work in a Chemical Engineering Research Lab with [a professor], which was really cool because I'd never worked in a lab before, and it was kind of a big responsibility to sort of give like a 16 year-old the ability to go into a research lab and try to do something, just to learn about how research works...So it was good to start forming that network. Some of those people are still close friends with me now, even three years into college.—African American Female – 3rd Year (P9)

Students described getting important information to help them through their engineering program, such as getting the both the academic and moral support needed to be successful in their programs. They also explained that through these kinds of programs they had opportunities to network with other students with similar ethnic and/or cultural backgrounds, and/or similar educational or socioeconomic backgrounds.

I got here, and we had this African American symposium thing. And one of the things that stuck out to me was – one of the guys said, “Unlike in high school where the guys who are almost flunking are getting a tutor, the A and B students out here are the people who are in the tutoring classes all the time.” And it only took me about a week to figure that out. But from then on, I was in the help lab and stuff for math, and it worked...And [The African American Symposium] helped me out as far as networking, because ...I met all these people that were in my field. And even now, I still talk to those guys, so it kind of helped me out...Kind of jump-started some networking.—African American Male – 2nd Year (P12)

Student mentoring and advising programs provided students with ways to tap their own experiences and provide support for younger students. They described mentoring incoming freshmen to help them get acclimated and oriented to campus and engineering, as well as to help them connect with other students.

Definitely, I know that for first year students, because [I am] a community advisor/orientation leader [and] I know for first year students the help is really huge...In the beginning of this year, when I was working with my group of freshman students...there was this one student that has a problem with one of his calculus classes...He was doing really bad in class and he came to me as his community advisor, his group leader, for help. And what I did, I spoke with my faculty advisor, I spoke with [the director] of the first year program...I sent him to MASH first for help. I sent him to the different programs...So I was able to connect him with the people he needed to for that...and I think he passed the course.—Latino Male – 2nd Year (P30)

Students also talked about participating in specific department support programs and/or interest groups that provided them with tutoring, peer support, and study groups, as well as opportunities to learn study skills from other students.

Yes, the department group that supports student learning, it's [Center of Academic Professional Enrichment], and, I've gone there. You can actually go and ask people for tutoring, and they assist you immediately. For mainly my engineering basis for study I can go to IEEE. IEEE is the club where electrical students go in, computer students go in, and you can ask anyone for any sort of tutoring advisement, so everyone always interacts and has their own little study group. And then here at [school] the women's center. The women's center, there too, you can also interact with not only women but also others too, and they tend to study around that facility. And last but not least, the library. People always study within the library all the time. There are study rooms where you can actually have a little enclosed area just to study on a one on one basis or with a group.—African American Female – 3rd Year (P14)

Students also explained that these groups helped them connect with students in their department and develop relationships and friendships with peers.

[A]s a freshman I was in a [first year interest group], and it was facilitated by the academic advisor for electrical engineering, so I guess that's another support group or mechanism...And we'd all go together to these tutoring sessions, and we always used to group-study together, and I still study with these people.—African American Female – 3rd Year (P25)

Some students also described Greek life as a source of community. While these organizations would seem to be social in nature, students described gaining access to various sources of academic support through sororities and/or fraternities, such as study groups, test banks and encouragement to do well. Students also explained that through community-oriented pledging activities, they focused on a common goal, learned how to work together effectively and developed an understanding for one another.

For me, I've always been one to make friends very quickly, and I've always been very open. But it also helped when I started pledging Crow [Alpha Chi Ro]...you get to know a bunch of people and after a while you start to understand how people work so you can – I don't know how to describe it I guess. So you work together better, more effectively, and that's what the pledge process causes is you have to work together, you have to get to a common goal. And it's learning, but it's pretty much what you have to do with everything else in the world. If you don't work together, there's nothing that's going to happen. There's no work that's going to be done, and you're just going to be stuck in a hole by yourself.—Latino Male – 1st Year (P28)

Students talked about how through these organizations they were able to find like-minded people, who may be seeking more of a balance between academic and social pursuits, and develop friendships with other students in their department.¹

[T]he guys I pretty much hang out with [are] -- we're here to study too, but at the same time, we don't spend our whole time worrying about getting straight A's...I would say most of the guys I

¹ Students did not indicate the ethnic make-up of these organizations.

hang out with, we take a more laid back approach. We don't focus solely on stuff. We like to kind of enjoy ourselves, but make sure at the same time, we get our work done...I do [feel connected to others in my department]. A lot of my fraternity brothers are in the same major, and specifically the guys, I have four guys in my class that are mechanical engineers, so... I'm actually going [to China] with one of my fraternity brothers.—Latino Male – 3rd Year (P29)

A couple of students described sports teams similarly to how others described Greek organizations in that the teams provided them with community and encouragement to succeed -- in both the sport and in their engineering program. They described coaches as playing a pivotal role in motivating and encouraging them to succeed in both. Much like the way some students described professional societies, students on sports teams seemed to find a sense of belonging and community through their teams, as opposed to through their engineering departments. Part of this could be explained by the fact that involvement on a college sports team makes it difficult to participate in any other co- or extra-curricular activities or programs.

[I] definitely [feel more connected with] my soccer team. You wake up in the morning, go to practice with these guys, and you live with them, you definitely feel closer with them than the students in engineering. Sometimes I look at those students I don't really fit, I guess. I'm not their type, or something like that... Your coaches definitely tell you to study. They push you as much as they can in both categories, which is really tough. Because here they want you to succeed in soccer at the same time they're telling you that you can't mess up in your studies as well... That's pretty tough.—African American Male – 1ST Year (P2)

While some students talked about involvement in a specific program, such as those previously mentioned, others referred to being involved in a variety of groups. They explained how involvement in multiple groups provided them with a variety of academic-related opportunities, such as conferences and scholarships and generally enhanced their engineering experience by making it more interesting and varied. Other students explained how involvement in various programs and activities can encourage unity, support and pride among students.

I'm really involved with different groups, and that makes life much better. Because not only do I go to class and learn this, but you have so many other opportunities. I go to conferences, in the college of engineering, involved in the college of engineering. Scholarship opportunities, they're everywhere. That's great too, as well, so the overall experience is great... So for example, I'm in SHPE, for example, which is Society of Hispanic Professional Engineers. There's also ASME, and I know a lot of my friends are involved with that, the women of engineering program—there are so many different things, it depends what you want to do. These groups [make] the engineering experience so much more enjoyable. It's not that I don't like engineering, but it's not really, really entertaining to just go to class every day and just class, class, class, do your homework.—Latino Male – 3rd Year (P21)

Peer Support

While a number of students described experiences that helped them integrate both socially and academically through involvement in co-curricular and extracurricular programs and activities, many other students referred to finding a sense of community and belonging through the peer support they found within their departments. Students described having opportunities to connect

with one or more students as a result of taking the same classes together and/or having similar course loads.

If I need help in a class, I'll ask someone I know in there. [The engineering students are] all very sociable...Yeah. They like to joke around, and get to know each other. And if you need something, they're there to be – “Oh, yeah, I can give you the notes or whatever.” It's helpful...It's not hard to approach someone, and ask them for something. [I feel connected to the students] that I know [in my department]. It's very easy to get along with them...it's mainly just because the people are so sociable; they like to get you to do stuff with them. It's a good thing for me, since I don't like to do things. It makes me want to go out and do things. Makes me want to go and make friends, and just go out and have fun.—Latina Female – 2nd Year (P6)

Through classes and labs they were able to meet friends and peers who could provide a sense of community as well as academic support. They also talked about spending a lot of time together on homework assignments, projects and studying for tests – in study groups or with one other person -- which helped create meaningful bonds among them.

I have lots of friends in electrical engineering. They're probably the ones I see the most, obviously, due to study groups and working on projects together and finishing labs and things like that. People are friendly...[Y]ou spend all your time with these people and you learn their study habits and you end up taking classes with them all the time still and stuff. So definitely that was good... Because by this point in my major, it's all – all the classes that I'm taking are with the same people, and I keep seeing them all the time. So definitely some of these people become good friends, not just like study buddies or the friends you see in class, but the friends you hang out with, the friends you tell secrets with, the friends you do everything with, and I definitely got really good friends from my major, some best friends..—African American Female – 3rd Year (P25)

Further, as a result of spending a lot of time with peers in theirs and other engineering departments, students talked about having things in common with other students and/or finding people who have things in common with them, which helped them feel more comfortable and less alone and isolated on campus. They explained that among students they had an understanding of the struggles they were going through, which helped them relate to one another.

I've been in some of the same classes with – because most of the bioengineering students have classes together. So I've had classes with them, keep in touch, ask each other about homework, even if we're in different sections, I still feel like I know people in bioengineering. So I never felt like, “Oh, I'm the only one.”—African American Female – 2nd Year (P7)

These bonds, along with their similar schedules, encouraged them to hang out socially together when not working. They described how this helped them get to know one another and develop meaningful and supportive relationships with one another.

I'm definitely friends with a lot of engineers, because we all struggle together to get by, so there's a lot of camaraderie...It's just mostly that we spend so much time in class, and doing homework, and doing lab, they're kind of the only people that we hang out with. And also for BMEs, we all have pretty much the same schedule... We all have to take Control Systems, we all

have to take Bio, Electronics...So we see a lot of each other. And if we all have tests, we all have tests in the same weeks. When we don't have tests, we hang out during the weekend, when others might have tests or homework.—Latino Male – 3rd Year (P3)

And I think I've sort of found my place in the department; I've created my group of study friends, and found my mentor, and I'm doing research that I like to do, and sort of becoming a little more active in the department with the Chem E Student Advisory Board...So it's – I don't know – it's just become a little bit more friendly to me. I feel like it's a large department; we have [a lot of] students in my graduating class...So I think it would be really easy to just fade into the background...But now that I'm feeling like there are a few people in the department who I actually have a connection to...I'm enjoying it more.—African American Female – 3rd Year (P9)

Many students explained that they always have someone to turn to for support. Some students may have one or more friends that they work with regularly. Other people will gather to do their work in a common location, and this allows them to give and get help to and from other students when needed.

One of the things that maybe I can throw out there is that...some of the core courses that you take, the class is very big because there's a lot of students taking it, so that helps because whenever you need help with something you can turn to another student. There are a lot of students that you know that are your colleagues that you know are in your class and you can turn to them and they can turn to you and you can help each other. So [that] helps you out a lot.—Latino Male – 2nd Year (P30)

Supportive Faculty and Department

A number of students found supportive faculty and department staff played a key role in helping them develop a sense of community and belonging. Students talked about making efforts to engage with faculty, such as introducing themselves to faculty and interacting with them in and out of class. This allowed them to develop relationships with faculty and receive academic support from them.

I always introduce myself to teachers. I interact in class so they identify me. So most of my teachers I've had since I've been at [school], know me by first name, just because I take the extra effort to introduce myself and do things like that. Now, like I said, there's not many people that look like me in the class, so it's easier to identify me...[I'm] developing relationships...It's like in the classroom setting, sometimes you might mess up on something. But if the teacher has a relationship with you, sometime they might give you the benefit of the doubt over somebody that they don't know. So there's trade-offs...There might be a recommendation later on down the road.—African American Male – 4th Year (P11)

Supportive faculty played an important role for many students' identification with and affiliation with their department. These professors were described as interacting with students in a variety of contexts, academically and socially. They were also described as approachable, available to students when needed, providing meaningful guidance, providing various opportunities to students, like giving them a chance to work on research projects, and showing dedication to

students. Some students even referred to having stronger and more meaningful connections with faculty than they did with students.

I like [the department]; they're very helpful. One of my teachers – she was my intro to circuit analysis – she would come online and chat with us at like 10:00 at night. So she could help us out with problems, which is probably unheard of amongst professors -- usually stay until five and then they leave - but she was very helpful. And the other professors – they go out of their way to help you. It's a very nice learning environment.—Latino Male – 1st Year (P19)

In addition to supportive faculty and advisors, students also talked about their engineering departments being generally supportive and helping them feel a sense of community. The qualities described by students included providing helpful guidance on classes, being organized, providing opportunities to interact with administration to improve programs, making students feel comfortable asking questions, helping students access the support they need, and being available to help. Students also described supportive departments as friendly, where people are easy to talk to and easy to get along with.

[T]he people are great; the people are real supportive. I can talk to my advisor whenever I need to; I could always just walk in there, which is always great. Professors are always very helpful; professors take us out to dinner after tests. Once you get into engineering classes, they're really there for you, and they're trying to teach you. They may be hard on you, but it's because they know you can do it...[What is the department] doing well?...I'd say definitely teaching applicable stuff to the field, and being there for whenever you need something. Guiding you along the way.—American Indian Male – 4th Year (P26)

Students talked about mentors as important sources of support and belonging on campus. Students explained how mentors helped them find and access resources, such as scholarships, internships, co-ops and jobs. They also helped students deal with issues and problems they faced, often providing step-by-step guidance. Students described them as showing dedication to them and having high expectations for them, again much like a parent would. Some students explained that it was helpful to get support from someone like themselves (i.e. a woman or someone with a similar background).

[I] definitely [have a mentor]. She's actually the coordinator for the program, women of engineering...I met her through my friend, which is her daughter. And she introduced me to her in freshman year, and she's been awesome. If you meet her, she's awesome. And she's really helpful. She helped me with searching for scholarships, if I had any problems in school, how to deal with them, how to look for a job here at school trying to find an internship or a co-op. And she's helped me a lot. And she's not only a mentor, she's the mentor for a lot of people, most of them women actually, but I'm the lucky guy that got to meet her. She's been great.—Latino Male – 3rd Year (P21)

Minority program staff played a key role for some students in helping them feel supported and like they belong on campus. Students described getting important information about campus, engineering and various programs through program staff. They also talked about having someone to turn to for support, much like a parent. Students also talked about the importance of supportive advisors in helping them feel a sense of affiliation with the department. They

described these advisors as being available to them when they needed help, boosting their confidence and providing clear and accurate guidance, particularly with regard to course selection.

[I have a mentor]...All of my other teachers haven't helped me as much as he has...And he has that dedication to his students that his students have to have back, and that was one of the things that have just really amazed me...he's pretty much my faculty advisor because I hate mine. I don't talk to him. [In] PLC he was helping through my homework – he was helping me do whatever. If I had a question, he would answer it...one of those relationships where you don't want to lose it because it's one of the best things that you have at this school coming for me. And I don't know, he's just always there, always willing to help.—Latino Male – 1st Year (P28)

Residence programs

Residence programs, such as living-learning programs, engineering dorms and engineering floors in dorms, also provide a variety of opportunities for students to create communities of support and develop a sense of belonging on their campuses. They provide opportunities for students to meet other engineering students in general, engineering students with similar cultural or ethnic backgrounds, and/or female engineering students. Students explained that in living learning communities, in particular, they have advisors on site to talk to and from whom they can get the help they need.

I'm actually living in the living learning community for engineering in our dorm room. So my advisors are both engineers for the RA and then we have the community advisor, which is specifically an engineer that's supposed to help out freshmen and stuff. So, I've been able to talk to them if I have problems.—Latina Female – 1st Year (P17)

Students who lived in engineering dorms talked about how living with engineering students at all levels (i.e. freshmen, sophomore and upperclassmen), creates a sense of community, and as a community, they work and socialize together. Many of them take the same classes together, or have taken the same classes, and people often form study groups and help one another with homework and projects. Through these experiences, they build lasting relationships that see them through college. Students who lived on engineering floors described some similar experiences. For example, they described studying together, as well as learning more than they otherwise would have, as a result of hearing about how different professors are teaching the same subjects.

I know on my floor – I live near a lot of MEs and we all have the same homework assignments. And we all get together and do them, and then we all have different professors. And so we'll get, "I didn't understand this when he said that." "Oh, well, my professor explained it like this." And we'll learn something through that, and it's like a melting pot of a bunch of different professors' takes on stuff. And we all have the same homework assignments for the most part though, so we all help each other out with those.—Latina Female – 2nd Year (P24)

Patterns & Themes across Race/Ethnicity, Gender and Year

When we looked at how students seem to be pursuing academic and social integration -- both of which contribute to developing a sense of community and belonging on campus -- across

race/ethnicity, gender and year in school, a number of patterns emerged. For example, we found that relative to other participants the Latina female students in the study did not reference involvement in co-curricular and/or extracurricular activities as much as other groups. Also, more Latino male participants talked about engaging with and receiving support from department staff and/or faculty than other participants. This was especially the case for first year Latino male students. Latino male students in their second year and beyond seemed to make more references to peer support than faculty support.

Interestingly, department and/or faculty support emerged as a common source of integration particularly for male students. Also, all groups tended to report more co-curricular and/or extracurricular involvement, more peer support and more faculty and/or department support, the further along they were in their programs, particularly third year students. In fact, all female participants in their third year reported some form of co-curricular and/or extracurricular involvement.

While only a handful of students talked about residence programs as important sources of integration on campus, most of these students were either female, Latino, or both. As would be expected, most of these references were also made by first and second year students, which is the time period when students typically participate in these programs.

Conclusion

Ethnic minority engineering students often face additional challenges in their undergraduate programs which can make them feel isolated.^{1-3,9} This isolation can hinder students' ability to integrate into their college campuses, and integration into the college environment plays an important role in students feeling a sense of belonging on campus, and ultimately in their decisions to persist.^{3,11} Therefore, it becomes important to identify strategies that can potentially help under-represented minorities develop a sense of community and belonging. This paper identifies four main areas which under-represented minority students in engineering described as helpful to their development of a sense of community and belonging. These four areas are co-curricular/extracurricular involvement, peer support, faculty and department support, and residence programs. Within these areas, many of the programs described were specifically related to engineering, but there were also programs described in which students found community and belonging outside of engineering.

Within co-curricular and extracurricular involvement, students described many benefits to participation in professional societies, department support programs, such as tutoring or study groups, student mentoring programs, orientation or pre-college programs, minority engineering programs, and women's engineering programs. Through these programs, students had opportunities to connect and develop supportive relationships with others who shared similar cultural and ethnic backgrounds.⁴ Students also recounted the benefits of Greek organizations, sports teams, and involvement with multiple groups. All of these activities related to other groups or programs that existed, and students reported the ways that these programs helped them connect with other students for both academic and social pursuits, providing them with both social and academic integration into their campuses.¹¹

Peer support is the second area that provided students with both social and academic integration. The descriptions of peer support were generally not connected to specific programs or societies, but were often related to being in classes with one another, feeling like you have things in common with others, and the helpfulness of peers around academic concerns. This type of support seems to develop more organically through the structure of engineering classes—students take the same classes with many of the same people, especially in their 2nd year and beyond. This type of generalized peer support was more often described by students later in their programs. Unless universities purposely place engineering students together in classes earlier, in a freshman interest group or something similar, there is no way to accelerate this type of support for students.

Department staff and faculty members can have important influences on students' sense of belonging and social and academic integration.^{11,12} Faculty can help improve students' sense of belonging by engaging students in their field and developing relationships with students, and by being supportive of students by providing guidance, being approachable and available when needed, and showing dedication to students. The department and department staff, especially advisors, can also help students feel connected to the department by providing quality guidance, being available to help and making students feel comfortable by being friendly. Students even described faculty and department program staff as mentors who helped them find jobs, internships, and scholarships, and provided guidance that in some cases was parental in nature.

Finally, residence programs were described as increasing a student's sense of community especially in their first two years. There were three main types of residence programs that students described: engineering dorms, engineering floors in dorms, and living-learning communities. Within these residence programs, students were able to connect with other students for studying and socialization, and were also able to procure assistance from the Residence Assistants (RAs) who performed the duties of engineering advisors.

While this study provides an in-depth examination of currently enrolled under-represented engineering students, we do not yet know to what extent the mechanisms used by URM students are the same as those used by non-URM students in developing a sense of community and belonging. In addition, while all the students in this study are currently enrolled in engineering majors, we have no way of knowing whether all of these students persisted to graduation in engineering. It is possible that despite the sense of belonging described by students, they chose to leave engineering for a different major.

Student sense of belonging has been found to be related to confidence in completing an engineering degree.^{2,3} Further, their social and academic integration into the college environment can contribute to students' ability to develop and access support, which can impact their decisions to persist.²⁻⁶ While academic and social integration can be more difficult for under-represented minority students⁷, this study identified a number of factors that lend themselves to both social and academic integration of minority engineering undergraduates. The study demonstrates that under-represented minority engineering students were able to derive a sense of integration, community and belonging using multiple means, and that the support mechanisms they used changed a bit over time. By understanding the different ways that under-represented minorities are able to integrate into their college campuses and ultimately find a sense of community and belonging, engineering programs can work to develop strategies to better support

under-represented minority students in their programs, potentially contributing to student persistence and retention, both of which can help increase graduation rates.

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