

Graduate Summer Bridge Program: Building Community and Preparedness for Success among Engineering Graduate Students

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Introduction

The transition to a graduate program is a challenge accompanied by many new activities, relationships, and general uncertainty about and familiarization with a new environment. Engineering graduate students must adopt new roles as junior colleagues or professionals in training as they enter and adjust to their new setting. That is, they must develop professional relationships with faculty members and fellow graduate students, working productively to contribute to engineering research all while undertaking increasingly challenging coursework. This challenge is magnified for members of underrepresented populations (i.e., women and minorities), and is further exacerbated when entering graduate students come from different schools than those which they are entering to pursue a graduate degree¹. In other words, while the transition to graduate school is a challenge for everyone, certain factors can amplify this challenge for different individuals. Thus, this article articulates a framework of a pilot summer graduate engineering bridge program and the assessment of its impact.

The transitions to new educational contexts are not unique to graduate education, and studies have examined the transition from high school into undergraduate program, particularly among engineering students^{2,3}. Conclusions from these studies suggest that increasing student familiarity with resources and creating a better understanding of academic expectations can facilitate acclimation to new environment. These findings have informed the development and implementation of “bridge” programs⁴. Bridge programs, which typically occur over the summer, invite students to attend abbreviated versions of the courses they will be taking in the upcoming fall semester. The objective is often to provide experiences that facilitate acclimation to university culture as well as familiarity with coursework, resources, and specific elements of student life that are likely to be unfamiliar⁴.

However, while some work has investigated the efficacy of summer bridge programs in helping students transition into undergraduate programs^{2,5,6}, less is known about the processes surrounding student transitions into *graduate* programs^{1,7,8}. Engineering graduate degrees are becoming increasingly important for professional and career development, and so understanding how individuals acclimate to graduate school environments is a critical first step in improving the overall process and ensuring competent graduates who are ready to effectively engage in professional practice.

Thus, this paper describes a framework for the development, and implementation of a pilot summer bridge for students from underrepresented populations as they transition into a graduate program. The outcomes from this pilot and the impact on the students are also assessed and presented here. More specifically, the authors investigate how a summer bridge program might facilitate the *academic and social integration* of incoming graduate students into a new and unfamiliar organizational context (i.e., the university). The program took place at a large, public, mid-Atlantic university (referred to as Public Mid-Atlantic University [PMAU] for this study). Students participated in a two-week sequence designed to give them the tools and experiences needed to succeed in graduate school and a chance to acclimate to their new surroundings in a low-stakes, highly supportive environment. Following their participation in the summer bridge program, student perceptions and experiences were explored using semi-structured focus groups and the transcripts were analyzed using qualitative methodologies.

This paper describes the development of the graduate summer bridge program and a preliminary qualitative evaluation of findings gathered from participant interviews. First, the authors discuss the

concepts of social and academic integration, and their relevance within the transition to graduate programs broadly. Next, we describe the development of the program in response to noted issues from past graduate students who had gone through similar transitions. Third, results from student focus groups are presented as they relate to social integration, academic integration, and perceived usefulness of the program. Finally, we conclude with discussions of the potential impact summer bridge programs for graduate students, benefits, drawbacks, and recommendations for fellow program developers.

Background and Prior Work

During the first year, incoming graduate students are integrated into their departments and colleges. Integration, broadly occurs through socialization to academic and socio-cultural norms by peers, faculty, administrators, and staff who play a role directly or indirectly in graduate education ^{1,7,8}.

Prior work has defined academic integration, specifically, as a process that describes how students are introduced to the norms of their environment. Acclimation to these norms provides information about critical elements of the graduate school process such as: which aspects of a disciplinary knowledge base are emphasized, expectations for entering graduate students' knowledge about core content, how students and faculty should work on research together in different lab settings, and conventions around publications and authorship ^{1,5,8}. For this paper, we define academic integration as the initial acquisition of knowledge about courses (i.e., what content is emphasized, pedagogy used, and pace of instruction), a basic understanding of what research with different labs and faculty are working on in the college, and successful ways to find an advisor.

On the other hand, social integration has been defined as processes that introduce first year graduate students to the manner in which peers interact with one another and how faculty and students socialize with one another, both inside and outside academic contexts ^{1,8}. While both are necessary for a successful graduate school transition, academic integration refers to the more overt, disciplinary practices, while social integration helps describe some of the more subtle, informal processes and the tacit knowledge gained from them. In the context of this study, social integration is conceptualized as knowing what the key resources are on campus that can help students navigate their first year and how to access them, and developing a group of peers that can provide support and serve as a knowledge base about the community and other resources on campus.

Literature has not discussed how a summer bridge program can facilitate the transition of first year graduate students; however, studies have looked at the extent to which bridge programs have encouraged the academic and social integration of undergraduates ^{9,10}. Findings indicate that exposure to programs and services on campus during a summer bridge can lead to long term benefits. In terms of benefits related to social integration, summer bridge program participants have more interactions with faculty and peers and have a greater opportunity to build supportive relationships and community that can positively influence their knowledge about expectations for performance than non-participants ¹⁰. Benefits include the continuation of these relationships and higher levels of social integration. Researchers suggest this is why summer bridge participants have a higher rate of retention into their undergraduate junior year than non-participants ¹⁰. Similar benefits have been seen related to increased academic integration among underrepresented students that participate in summer bridge programs as entering freshmen. Underrepresented students who participated in a summer bridge noted that they better understood academic expectations and had developed a social network at higher rates than their non-participant peers ⁹. Despite the literature focusing primarily on benefits of summer

bridge programs for undergraduates the overall design and purpose of the programs suggests that graduate students will likely benefit from these types of programs as well.

Program Development

The purpose of the summer bridge program was to smooth the transition for incoming engineering graduate students who were *both* demographically underrepresented *and* matriculating from a different undergraduate university. Given the unique challenges these individuals face upon entering this new context, the experiences of past graduate students were leveraged to inform the development of the summer bridge. A group of current engineering graduate students who were primarily from underrepresented groups (i.e., women and racial/ethnic minorities) identified key areas where graduate students new to the university (i.e., those matriculating from a different undergraduate program) might be disadvantaged and need further support. Through personal reflection and discussion with faculty members, this group of underrepresented students identified three key challenges related to academic and social integration that were part of their own experience transitioning to graduate school at PMAU:

- 1) A lack of coordinated faculty connections and research experiences within faculty members' labs, including the opportunities to see several different project opportunities and working environments;
- 2) Instructors that assume first year graduate students have been taught fundamental concepts in the same way that matriculating PMAU engineering undergraduates would be taught;
- 3) Fragmented opportunities to build community with other underrepresented students.

In response to the challenges associated with both the transition to graduate school broadly and those noted specifically by senior graduate students at PMAU, a summer bridge program was developed and implemented in the summer of 2015. Academic activities were used to refresh and advance students' understanding of key disciplinary concepts and lab rotations were used as a way to create networking opportunities. These experiences were designed to provide students with a sense of the academic norms (e.g., how core content was taught), expectations for entering graduate students' knowledge base, and how students and faculty conduct engineering research in different lab settings. Students were also provided with professional development opportunities that allowed them to gain a better understanding of campus life and social norms in the college and department including how faculty and students communicate with one another in academic and non-academic settings.

Program Recruitment

Invitations to participate in the summer bridge were sent to a select group of entering engineering graduate students in three departments major engineering departments at PMAU. Students that received the invitation were a subset of the entering graduate student population in these three departments who would be receiving tuition and stipend through a diversity program (name omitted for anonymity) in the College of Engineering. The program is supported by a group dedicated to highlighting the contribution that diversity can make to the process of research and discovery. Scholars within the program include engineering graduate students who did not receive their undergraduate degree from PMAU and have traditionally been underrepresented in graduate engineering programs (e.g., females, racial/ethnic minorities, veterans). Of the 11 entering Scholars departments that received the invitation, 9 agreed to participate in the summer bridge program.

Program Structure: Addressing the Challenges

The bridge program was offered in the two weeks prior to the start of the fall 2015 semester, and was designed to address challenges noted above by prior cohorts of New Horizons graduate students. Over the course of the two weeks, students engaged in activities designed to promote both academic and professional development. Generally, sessions were divided into two parts. During the first half of each day, students participated in problem-based learning (PBL) engineering activities and seminars given by various faculty members, with the second half of the day typically spent in different labs around the campus. The following sections describe in more detail the different elements of the two week program.

Academic Content

During PBL activities, students worked in small groups, facilitated by different members of the instruction team, to solve open-ended engineering problems. The problems were designed to address content identified by faculty and students as important for success in subsequent graduate coursework (e.g., programming, heat transfer, solving linear systems, statistics). Because the student teaching team had experience with the coursework at PMAU, they were able to develop content and learning activities that would be most useful for the participants' early graduate careers. Importantly, the PBL design of the lessons helped build students' problem solving and information-seeking skills more generally^{11, 12}. Thus, students received a refresher in academic content (i.e., challenge number 2) while also gaining skills related to self-directed learning, communication, leadership, and teamwork skills noted by the Council of Graduate Schools as critical for success in graduate studies.

In the second half of the day, students participated in "lab rotations." During these sessions participants spent time with different professors and graduate students, working and learning about research underway around campus. Each student spent one day in each lab, for a total of 8 labs in 10 days. By seeing firsthand the activities that engineering graduate students and their advisors do, incoming graduate students can develop a much more concrete picture of what graduate student work looks like as well as how different student-advisor relationships might be negotiated. These activities help address challenge number 1 above while also providing opportunities for incoming students to select a potential lab or research group.

Professional Development

In addition to academic activities, one morning was used to organize a panel of senior graduate students without the presence of faculty or administrators. Facilitated by the instructional team, summer bridge students were given an opportunity to ask more senior graduate students questions about their experiences entering and succeeding in graduate school. The purpose of the panel was to give students an opportunity to ask questions that are important, yet are rarely explicated within graduate programs. For example, finding and selecting a research group can be challenging and uncomfortable for many students, and the graduate student panel provided stories, advice and strategies for initiating those conversations.

Learning the rules and norms of an organization is often a process of informal learning of tacit knowledge^{13, 14}, but that learning is sporadic and non-uniform across graduate students. The result is potentially leaving many newcomers with gaps in their knowledge regarding the processes of graduate school. A panel of peers who can make explicit some of the implicit knowledge can help students more confidently navigate their environment.

The literature on successful transition programs indicates that students should know what services and resources are available to them^{5, 15}. During these sessions, participants had the opportunity to meet with personnel from different support departments on campus, including the university librarian who is

designated to work with the College of Engineering, representatives from the Writing Center, and staff from the Graduate School who oversee diversity programming and efforts.

Social Events

Further, in response to challenge number 3, the program organized social events for students participating in the summer bridge program. During the evenings and some lunches, social events were organized in which students could network with each other, various members of the instructional team, and New Horizons program developers and administrators. Creating time for informal, social opportunities is an important element of easing the transition to a new setting, as it helps participants build personal and professional connections that they can leverage throughout their time as graduate students.

Overall, the summer bridge was designed to address challenges discussed in the literature surrounding organizational transitions broadly as well as those noted by members of a particular organization locally.

Methods

As noted above, prior research regarding the transition to a graduate program is sparse. Thus, the authors present a qualitative approach in which we explore how a purposefully designed graduate summer bridge program might impact the academic and social integration of underrepresented engineering students in their early graduate education. When phenomena of interest are not well understood or sensitizing concepts not well-defined, qualitative approaches can provide initial insight into salient aspects of particular events^{16, 17}. In order to better understand the ways in which summer bridge program achieved the program goals by facilitating academic and social integration, we invited students to express, in their own words, their experience with the program and what impact it may have had.

Sample

Following approval by the Institutional Review Board, students of the summer bridge program were invited to participate in a focus group session approximately mid-way through their first semester of graduate school. The time frame was selected to allow students to accumulate a sufficient experience with the everyday activities of graduate school without forgetting how the summer bridge may have impacted them. All nine participants received an email invitation with potential dates and times identified for the focus group and told that they would be provided with a small meal during the focus group to encourage participation. In total, five of the nine participants attended comprising two total focus groups.

Data Collection: Focus Groups

During semi-structured focus groups, students were asked questions designed to illicit information about how they interacted with faculty, what they learned about current research projects, and the extent to which summer bridge activities touched on foundational concepts and how they are taught at PMAU. During the focus groups students were also asked questions about how they learned about university and college resources and how they developed social networks. Interviews were transcribed verbatim and any identifying information was removed from the transcripts.

Data Analysis

The transcripts were analyzed using an *a priori* coding process¹⁸. Three broad categories of academic integration, social integration, and general program feedback served as an initial coding scheme. Participant experiences were coded within these three areas. Greater delineation in the codes were made as themes emerged. Each member of the research team coded the transcripts on their own and

then compared the themes and codes that emerged. Differences in coding schemes were reconciled until the research team had a final set of codes.

Results

From the perspectives that participants shared on the summer bridge, the experience seems to have facilitated both social and academic integration. Specifically, our findings suggest that in relation to social integration participation in the summer bridge program allowed the first year graduate students to create a social and professional network across the college. With regard to academic integration, participants felt that the program helped improve their understanding of graduate school course work and how research is conducted on campus.

Social Integration

In terms of the definition guiding our study, the participants explained they experienced social integration by learning about what key resources are on campus and how to access them (e.g., Writing Center) and they also developed a group of peers that appear to provide support and serve as a knowledge base about the community and other resources on campus. The summer bridge program participants explained that on a basic level they “became more familiar with the campus and the environments.” With regard to the campus, the campus tour on the first day introduced them to “a few different buildings [and a] few other services on campus.” Compared to their other first year peers, they felt more aware of a vast number of resources on campus at the department, college, and university levels. Bridge participants noted that they expected graduate school to be challenging but having the summer bridge program allowed them to develop a network of support they could rely on moving forward.

Social integration was also facilitated as students acquired a diverse, social network on campus. A participant explained, “We are all coming in from different schools...so we are not familiar with the environment, the people, the teachers...but coming into the [summer bridge] program has given us a bit of a network.” The coordinated activities allowed them to connect with a fellow students in their department and others across the college. These connections included building relationships with other underrepresented students; an important aspect of successful transition as noted by the participants. One student explained “I am pretty happy about being able to know diverse people on campus. And then they also introduced me to more, other diverse groups, like on campus.” Given the program emphasis on creating community and social integration specifically among underrepresented students this finding is especially worthwhile to note.

Social integration appears to be facilitated as participants explained that building this network was “extraordinarily important” to them because it increased their comfort level. Moreover, summer bridge participants explained that they felt connected to one another as they had a “shared experience” with peers that participated in the summer bridge program with them. Creating a diverse social network on campus was further facilitated as communication has continued among the program participants through a texting listserv. Students explained that the “Groupme app” (i.e., a mobile application that facilitates group chats) allows them to ask questions about events on campus or common classes they are taking and get an immediate response from one another. The social network they started over the summer was also facilitated by the living situations that developed as a result. Two participants noted that the summer bridge program connected them to their current roommates.

In addition to forming meaningful peer relationships, participants’ networks also expanded to include university personnel. Students discussed how the program had provided them with opportunities to meet “people sort of high up.” These interactions introduced them to additional resources as one

participant explained how this encouraged familiarity with many different aspects of graduate school: "...familiarity with the campus, familiarity with some people who can give me advice....It's really good because they can point you toward resources that you just never know of yourself." Participants explained that participating in the bridge program gave them exposure and connections to faculty that they could leverage later on in their studies. One participant explained, "...it's better to start with 'I was in your lab for this [summer bridge] program and you mentioned this' than it is to say just something, it puts you out from the crowd compared to some other person..." To the participants, meeting these professors through the summer bridge program separated them from other students, giving them a foot in the door when it came to communication.

Academic Integration

In the context of this study academic integration appears to have occurred as participants acquired initial information about key courses to take in the first year of study and how those courses are delivered, a basic understanding of what research different labs and faculty are working on in the college, and successful ways to find an advisor.

Participants described how the summer bridge experience helped them gain a better understanding of how research was carried out in different settings. Students explained that the lab tours gave them opportunities to explore different types of research going on in labs across the college. The experience exposed students to interdisciplinary work through lab tours and helped them consider how to gain this experience during their graduate school experience. This participant explained, "There were different meetings where you would go to somebody's lab as a group and hear about their research." This student went on to explain, "I found that interesting for just the reason of wanting to know what was going on throughout the college of engineering, as well as like my research is multidisciplinary there maybe I may want to tap people who are relevant to my research to work with in the future."

Another noteworthy aspect of academic integration that was facilitated during the summer experience was exposure to different faculty. One student noted that he found a permanent advisor through the lab tours, explaining, "I found my lab through the summer bridge program. If it hadn't been for the summer bridge program, I am not quite sure what exactly I would be doing right now." Selecting an advisor and research group can be a significant challenge for incoming graduate students, with many important factors contributing to the fit and effectiveness of the relationship. The summer bridge program appears to have facilitated that interaction for at least one of the participants.

Also related to academic integration, students learned lessons about graduate course loads and topics of interest. For example, students were given advice regarding how many classes to take. As one participant noted: "I learned to take two classes, no one was taking three...so like take two classes, do research and then take some time to rest..." This advice was echoed by another participant who explained, "I have to say like probably like people said multiple times not to take three classes your first semester and I ignored that advice to my detriment." Another student explained that they "found which classes to take during the experience." Selecting the right number and kind of graduate courses may not be a straightforward process for those unfamiliar to the university, and summer bridge students acquired the information needed to inform those decisions.

Students also gained a better understanding of the formal examination procedures of their departments. Students learned more about the actual checkpoints and milestones involved in the PhD process. One participant explained, "I learned what that [a qualifying exam] was. I came as a master's student interested in a PhD. But I wasn't like too sure what was involved in getting a PhD. And I sort of learned how qualifying exams work for each major." The people that the participants interacted with also facilitated academic integration by explaining how to best approach qualifiers. As one student

explains, “[A senior level graduate student] recommended vibration and some other courses in terms of getting prepared for the qualifying exam and tips like that.”

Usefulness and Areas for Improvement

While themes of Academic and Social Integration informed the development of the program and data collection processes, it was also important to explore, more pragmatically, aspects of the program which participants found useful or in need of improvement. Given the varied backgrounds and degree programs of the participants, the technical content of the lessons were not always aligned with their current experience. That is, the material was too challenging for some, too simple for others, and at times not directly applicable for every participant present. As one student explained, “...it wasn’t too useful for me because my background and the field that I decided to go in.” Participants had the most positive things to say about the academic lessons that were not discipline specific, like the library instructions, writing center introductions, and overviews of available resources.

Still, some students did indicate the material covered in the academic sessions was useful, serving as a refresher. Programming was one specific area that participants explained helped them in their transition. For example several participants explained the usefulness of revisiting the programming language used most often in their departments. As this student noted, “it was good to get a refresher on MatLab.” Academic content also helped students acclimate to the structure of school and activities of grad student life. One participant had been working full time in industry before attending the summer bridge, and explained how his participation got his “brain working again.” By engaging in academic work, students were able to become acquainted with graduate school norms, customs, and values.

The focus groups also revealed areas that the program could be improved to facilitate academic integration further. For instance, participants suggested it would be useful to hear more about what classes to take and an overview of what classes are available on campus. They suggested this could be done by having an advisor spend time reviewing their planned courses and provide feedback before classes started. Participants explained it would be helpful to hear about fellowship opportunities available at the university, or through national organizations, so they were prepared to consider how they might shape their first year to apply for them. Finally participants noted that it would be helpful if the summer bridge program could replace some of the discipline based lessons with a more general topic such as how to manage the amount of reading assigned in graduate school.

Discussion

In a number of ways the summer bridge participants suggested that program participation helped facilitate academic and social integration. In terms of social integration, the activities helped accelerate the socialization process by creating a better understanding of the campus environment. Participants knew where different buildings were located and had a general idea of which labs were housed in them before the start of their first class. The program helped provide participants with an expanded social network of peers, faculty, and academic administrators before they started their first semester of graduate study. Participants suggested that having this extensive network, especially one that included other underrepresented students in engineering programs, made them feel supported and prepared to address challenges they anticipated encountering during their first year of study.

With regard to academic integration, participants felt they gained a better understanding about how graduate education was approached in their department. Summer bridge participants started their first semester with an understanding of how many classes to take and how to approach preparing and studying for qualifiers. This knowledge made the participants feel more prepared and confident to start their graduate careers. Introductions to the interdisciplinary research and faculty engaged in those

endeavors provided participants with a comprehensive view of how research was carried out in labs at PMAU. Participants indicated that having this knowledge at the outset of their graduate career helped them consider how they could incorporate interdisciplinary research experiences such as this into their immediate future.

Given the small number of participants in this study we hope to follow-up with other summer bridge participants in the future that were not able to make the scheduled focus groups and follow the interview protocol that was used with the focus group attendees. Doing so may enhance our findings from the five focus group participants and it may also reveal other ways that the summer bridge program facilitated academic and social integration. Given the small sample size this study used a qualitative approach and focused only on summer bridge participants. In the future we plan to track the progress of the summer bridge participants in terms of academic performance and retention to future semesters. We also plan to conduct focus groups with a matched sample of engineering graduate students who did not have the opportunity to engage in the summer bridge program. We hope that by doing so we can better understand how the summer bridge program facilitates integration and encourages retention. By interviewing non-participants it might also allow us to understand factors that aid in integration that were not previously included in the summer bridge agenda.

Our findings are also useful for other scholars and program developers. The program development and implementation described here can help others create a summer bridge program at their universities for graduate students entering engineering programs. An important part of the development process for this program was the incorporation of current graduate student reflections on their own experiences. Consideration of the challenges and pitfalls of similar students who have persisted despite participation in a summer bridge was critical in developing meaningful learning activities. Those experiences may be unique to PMAU or the underrepresented students that engaged in the reflective activity, but an important aspect to consider, and indeed the idea that may generalize beyond the case presented here, is that the program responded to the specific needs of individuals for whom it was developed. That is, careful consideration of the unique needs of a particular group formed the foundation for program development. It would behoove administrators to identify what the most challenging aspects for entering graduate students are as they transition to their respective university and how they might differ across student populations.

Administrators and faculty can also examine the itinerary of the summer bridge program and consider the balance of academic and social activities for their incoming graduate students. In particular, our participants were aligned on positive perceptions of social or professional events, but not on perceptions of technical content. The lab tours, professional development panels, and general topics such as how to use the library resources were identified as the most useful to students. These were sessions that made the incoming graduate students feel more knowledgeable and sparked conversations and thought processes about how to approach their first year. The technical course content received mixed reviews with some participants finding it more helpful than others. Administrators may want to consider what concepts to teach and how to teach them to maximize student benefits.

In conclusion, the summer bridge program appears to have achieved the initial goals to facilitate academic, research, and social integration among incoming underrepresented engineering graduate students. Offering and assessing the impact of this program is an important first step in gaining a better understanding of how to facilitate the transition of all engineering graduate students, including addressing challenges unique to women and underrepresented racial and ethnic minorities in graduate engineering programs. As we look to continue to attract underrepresented students to our university we

plan to offer the summer bridge program again. The findings from this study will be used to inform future summer bridge offerings for our engineering graduate students.

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