



## Participatory Action Research (PAR) as Formative Assessment of a STEM Summer Bridge Program

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Dr. Susan Thomson Tripathy received a Ph.D. in Anthropology from Harvard University in 1989. Her doctoral research was funded by a Fulbright-Hays Doctoral Dissertation grant, and utilized ethnographic fieldwork in rural Bihar, India, to analyze the politics and artistic development of a local dance form. From 1995-2007, Tripathy taught behavioral sciences at Middlesex Community College (MCC), where she was an active participant and researcher in MCC's extensive community service-learning program. In 2007, she became the Director of Research at Germaine Lawrence, a residential treatment center for adolescent girls in Arlington MA, focusing on program evaluation and outcomes after discharge. Since 2011, Dr. Tripathy has been teaching in the Sociology department at University of Massachusetts Lowell. She received teaching awards for applied and experiential learning in 2013 and 2014, was promoted to Associate Teaching Professor in 2018, and received the UMass Lowell Teaching Excellence Award in Sociology in 2018. From 2016-2019, Dr. Tripathy was the Director of the Bachelor of Liberal Arts program, an interdisciplinary major with an enrollment of 250 undergraduate students. In 2018 and 2019, she collaborated with Dr. Kavitha Chandra to utilize participatory action research (PAR) as an evaluation approach for the Research, Academics, and Mentoring Pathways (RAMP) summer program for first-year female engineering students.

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# **Participatory Action Research (PAR) as Formative Assessment of a STEM Summer Bridge Program**

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*Abstract* - Research, Academics and Mentoring Pathways (RAMP) is a six-week summer bridge program offered to incoming female undergraduate engineering students at the University of Massachusetts Lowell. Initiated in 2018, the goal of this program is to increase the enrollment, retention, and success of female engineering students as they enter the Francis College of Engineering, continue with their studies, and graduate into the workforce. The objectives are to encourage research participation, improve student content knowledge in gateway courses such as Calculus, and increase their sense of belonging, preparedness, and self-efficacy. To understand student perspectives and experiences, we utilized Participatory Action Research (PAR) to construct a series of formative assessments prioritizing the views and participation of the RAMP students themselves. PAR was selected as a research and assessment strategy due to its emphasis on student participation and empowerment linked with action for positive change. Online surveys and four focus groups involved the students in topics geared towards developing a psychologically safe space for sharing experiences, providing feedback on program activities, and reflecting on personal goals, values, and aspirations. Based on our findings, we identify key insights learned from using PAR for formative assessment and explain why this approach may be especially helpful in creating more supportive and beneficial environments for women in engineering education.

## **1.0 Introduction**

Research, Academics and Mentoring Pathways (RAMP) to Success is a summer bridge program offered to female engineering students entering the University of Massachusetts Lowell as first year students in the Fall semester [1]. This six-week program is designed to provide new students a smooth transition from high school to the University environment, allowing them to build a community of friends and explore the resources available to them during the relatively quieter summer session. First implemented in 2018, RAMP enrolled 22 students in its first year and 15 students in 2019. RAMP began in response to the University's mission for improving its gender diversity in science and engineering programs. In the Francis College of Engineering (FCoE), the percentage of women entering the program has been increasing with the establishment of the new Biomedical Engineering program (started in 2015) and the Environmental Engineering degree that began in 2018. In the Fall of 2019, females were 17% of the 3064 undergraduates enrolled in engineering. One of the objectives for RAMP is to make students aware of the diversity of career options available across all of the engineering majors and introduce them to the potential of interdisciplinary research. Towards this end, introduction to research and interaction with engineers and scientists from industry are two important components in the RAMP program. To get accustomed to the new demands of course work, participants also take four credits of their first mathematics course, Calculus 1. The connection to potential mentors is

enabled as students meet several faculty members, graduate students, administrators, staff, junior and senior level undergraduates each of whom has unique messages for the participants.

To understand the perspectives of students as they progress through the RAMP program, we utilized Participatory Action Research (PAR) to construct and implement a series of formative assessments involving focus groups and online surveys. PAR is a social science research framework that prioritizes the views and participation of all stakeholders affected by the problem under investigation, and uses this information to bring about constructive change. Methods used in PAR may involve a diverse range of activities, such as focus groups, surveys, diaries, participant-observation, photovoice, mapping, and interviews [2,3,4]. The experiences and concerns of women in engineering majors and careers are multi-faceted, and have been studied using PAR and other qualitative approaches [4,5,6,7]. Formative assessment may be defined as “encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged” [8, pp.7-8]. Educators have frequently used formative assessment in STEM classes to assess students’ knowledge of specific academic content and/or skills on an on-going basis [9,10,11]. These assessments are typically designed to examine how students are meeting pre-determined learning goals, rather than allowing students themselves to help determine these goals. By pairing the educational concept of formative assessment with the social science research approach of PAR, we emphasize the interdisciplinary context of our approach and its importance for understanding how best to improve the retention and achievement of women in engineering majors and careers. Overall, PAR enables us to focus more holistically on students’ perception of their learning experiences and provides a safe space for students to self-reflect, set personal learning goals, and critique their experiences.

While PAR has been used extensively in STEM educational research [12,13,14], to the best of our knowledge, no published reports link PAR with formative assessment strategies in engineering bridge programs. These programs are important to examine, because they serve as an initiation into engineering majors and are usually students’ first encounter with the college environment. A recent literature review of bridge programs stresses the need for effective formative assessment to bring about positive changes in future iterations of these programs [15], and another review points out that few assessments of bridge programs have used qualitative methods [16]. A notable exception is a qualitative analysis of the Meyerhoff Scholarship Program at the University of Maryland Baltimore County, which utilized focus groups to elicit student perspectives on a variety of program-related topics [17]. In this study data from the focus groups is used to validate program goals and outcomes, rather than as an action strategy and formative assessment to involve student voices and feedback in constructive program changes.

For the RAMP program, the problem being addressed is the low rate of participation by women and minorities in engineering degree programs, and subsequent low rate in engineering careers. A related issue is the lower level of active participation in classroom discussions by women as compared with men [18]. By using PAR strategies as a formative assessment, we intend not only to learn more about the perceptions and experiences of women attending RAMP, but by collaborating with these students, to use this co-created knowledge to modify and improve the RAMP program. We aim to develop empowerment strategies that will help women succeed academically and foster overall well-being, thus increasing the likelihood they will stay in an

engineering pathway well beyond their undergraduate degrees. Based on our findings using PAR focus groups and surveys in the RAMP program, we will demonstrate how we used data collected from the 2018 RAMP cohort to improve the 2019 RAMP program, and how we propose to continue this iterative process in the 2020 RAMP program. As we write this, RAMP in 2020 is expected to be fully online, a virtual program, as we shelter from the Covid-19 virus. Finally, we suggest why the PAR approach may be especially helpful for creating more supportive and beneficial environments for women in engineering majors.

In Section 2.0 RAMP student recruitment and demographics are discussed. The design and implantation of PAR focus groups and online survey methods are presented in Section 3.0. Section 4.0 shows the results of data analysis and Section 5.0 summarizes the contributions and outlines future work.

## 2.0 RAMP Student Recruitment and Demographics

The RAMP program is advertised to all students admitted to the FCoE, starting with early action decisions that take place in November of the previous year. Recruiting takes place at open-house and welcome day events when admitted students visit campus and through media mailings and telephone calls made to eligible students. Students indicate their interest in joining RAMP on an on-line registration form located on the program website. These students then complete an application expressing their reasons for choosing engineering, current goals, interests and concerns. Each applicant also participates in a telephone interview with the associate dean. Applicants are selected based on their commitment to fully participate in all of the program events. The six-week schedule is a fairly intense 8am – 4 pm, five day a week program. But it is also carefully designed to include various types of social events interspersed with the research and academic components.

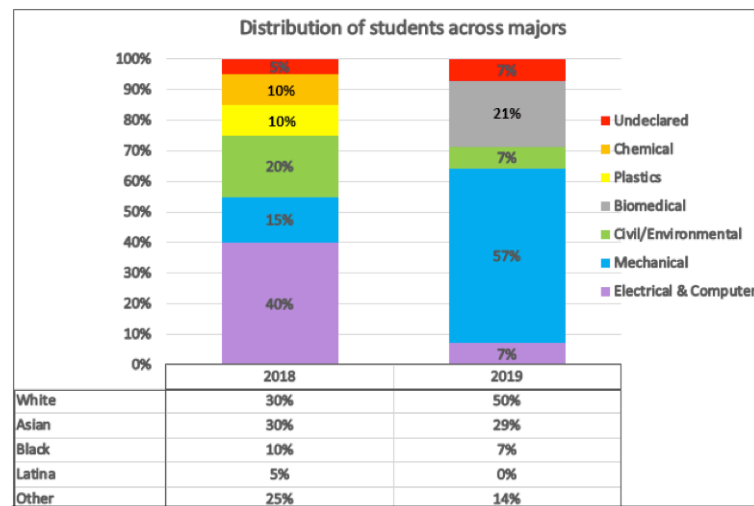


Fig. 1: Participant demographics with respect to chosen major, race and ethnicity. Note: “Other” includes students who identified as Haitian, North African, and bi/multiracial. Data collected from an online survey. \*One RAMP 2019 student chose not to participate in the survey.

In both 2018 and 2019, the RAMP students were all women who were going to begin freshman year in the Fall in eight different engineering majors. Twenty students completed the RAMP program in 2018, and fifteen students completed in 2019. The 2018 and 2019 RAMP students represented a variety of engineering majors and racial/ethnic backgrounds as shown in Fig. 1. A majority of students in both cohorts (78% for 2018, and 71% for 2019) had at least one parent whose highest educational degree was from a 4-year college. Approval was obtained from the UMass Lowell Institutional Review Board to conduct a research study aimed at

assessing student experiences and perceptions of the RAMP program. The goals and procedures of this study, including the PAR process, were then explained to RAMP students at an initial group meeting. All of the RAMP students age 18 and over consented to participate by signing written consent forms. For students under age 18, parental consent and student assent was also obtained. The consent and assent forms included permission for the focus groups to be video-recorded and transcribed by the researchers and also affirmed that students could withdraw from the study at any time without affecting their participation in the RAMP program.

### 3.0 PAR Focus Groups and Online Survey Methods

To provide a space for reflexive discussion and formative assessment of the RAMP program, four focus groups were designed by the research team and implemented at bi-weekly intervals, each organized around different topics and activities. Focus groups were specifically chosen as a research method to encourage open-ended conversations and allow the RAMP students themselves to initiate questions and engage in activities together, thus building rapport and community. Data collected thus reflects not only individual perspectives, but interactive dialogue with peer facilitators and other students. Models for these groups were drawn from effective practices and suggestions from staff at Ekjut, a NGO located in Jharkhand, India that uses PAR methods extensively [19].

During both 2018 and 2019, the RAMP cohort was split into two different groups, with 7-10 students in each group, resulting in eight focus group meetings during each six-week program. Students were assigned to these groups to obtain equal numbers of students in each group and allow the same students to meet together each week. The discussions centered on the four topics and activities shown in Table 1.

**Table 1:** Focus group topics, the goal and synopsis of activities

<p><i><u>Focus Group One:</u></i> Introductions and <u>what is the one thing you're excited about learning/doing in RAMP?</u></p> <p><i><u>Goal:</u></i> Explain the purpose of the focus groups, develop rapport, and create a safe space for sharing opinions, feelings, and experiences.</p>
<p><i><u>Activity:</u></i> To facilitate this process, students were given a list of “ground rules” for focus groups emphasizing the following: all voices are important and should be heard; participation is voluntary and you can “pass” if you prefer not to respond; there are no “right” or “wrong” answers; and personal information shared in the focus group should not be repeated to others once the focus group ends. Students wrote each other’s expectations about RAMP on a large sticky note placed on the wall, so all could participate and comment on each other’s ideas.</p>
<p><i><u>Focus Group Two:</u></i> <u>How can you keep your engineering career in orbit?</u></p> <p><i><u>Goal:</u></i> Using the metaphor of planets orbiting around the sun, allow students to consider both similarities and differences between themselves, and what they need to do and need from others to keep their engineering career in orbit.</p>
<p><i><u>Activity:</u></i> Students were asked to choose a card with a photo of a planet or moon in the solar</p>

system, and then each person commented on how their planet or moon was similar or different from the rest. This led to a discussion of how RAMP students are similar and different, and ways to help keep their engineering careers in orbit. A written list of these ideas was then generated and shared with all students.

*Focus Group Three:* What is something that surprised you about RAMP?

*Goal:* This discussion served as a “check-in” to see how students were reacting to what they had learned thus far, as well as what they would like to learn in the future.

*Activity:* Students were asked to choose gemstones/rocks and to place them in the center of the table as they spoke, to symbolize and ensure that everyone’s voice was heard.

*Focus Group Four:* What are your core values, and how do they align with skills learned at RAMP?

*Goal:* Provide students an opportunity to identify their core values, recognize how they align with skills learned at RAMP and long-term career aspirations in engineering, and share their thoughts with each other.

*Activity:* Students participated in a “Tree” values clarification activity to identify core values and associated skills: Roots (core values), Trunk (skills learned at RAMP corresponding with these values), Leaves (dreams and aspirations) and Sun/Rain/Environment (people who motivate you). The values clarification aspect of this activity was adapted from the “live your core values exercise” at Taproot.com [20].

The meetings were held during lunch break and lasted one hour. Students were able to have lunch, which was provided by RAMP during the focus groups. The sessions were videotaped and later transcribed. Following procedures for qualitative data analysis [21, 22] transcripts were then coded and emergent themes identified by one of the researchers and discussed with the research team. In addition, student comments and suggestions about their experiences in RAMP were reflected upon and program adjustments made on an ongoing basis. In this way, our use of focus groups departed from the “group interview” approach used in many qualitative studies, and instead aligned with typical PAR cycles of initial planning (designing the focus groups), action (facilitating and participating in the focus groups), observation (observing, coding, and analyzing themes from the focus group activities and discussions), and reflection-informed planning (reflecting on student feedback and enacting RAMP program changes based on this reflection) [23].

In 2018, a faculty researcher facilitated the focus groups. In 2019, responding to student feedback, this researcher trained two students who participated in the 2018 RAMP program to be peer facilitators, and also trained the program coordinator for undergraduate engineering programs, who then became a member of the research team. Guidelines for the focus groups, including instructions for each activity, were provided in a written booklet, and were also discussed in a 2-hour training session. Once the focus groups began, the faculty researcher reviewed videotapes of the focus groups after each session and provided feedback to the peer facilitators so they could make changes as needed.

In addition to the focus groups, online surveys were administered to all RAMP students during the final week of the program. These surveys included basic demographic questions (engineering major, race/ethnicity, parents' education level), and also asked students to rate different aspects of the RAMP program. To triangulate data collected in the focus groups, open-ended questions were included inquiring about challenges, suggested improvements, and overall experiences in the program. In 2019, open-ended questions were also included specifically about student experience in the focus groups.

## **4.0 Data Analysis**

In the analysis below, data from the first three 2018 and 2019 focus groups and the online surveys will be presented and compared. Following PAR methodology, our approach to the focus groups was iterative, and thus changes were made in 2019 based on what we learned during 2018. The purpose of this comparison is to see what we can learn from student perspectives and the PAR reflection/revision process, and how this knowledge might be incorporated into the next iteration of RAMP in 2020.

### ***4.1: 2018 Focus Group Data Analysis***

#### *Student-defined learning goals/aspirations for RAMP*

When asked during the first focus group what they were excited about learning during RAMP, responses emphasized academic, professional, and social goals. "Getting a head start on everything" was an overarching theme. Academic skills students hoped to learn and/or accomplish included programming, completing Calculus credits, mini-projects, working with other majors in projects, and coding. Social skills connected with academics included getting to meet and connect with professors and mentors. Professional goals included visiting companies such as the New Balance Company, meeting environmental engineers, meeting inspiring people such as panel participants drawn from several local companies, and improving communication skills. It is important to note that New Balance Company stood out, because this visit highlighted to students the varied nature of engineering careers that may be available to them. Finally, several responses emphasized social connections and getting used to life on campus, such as making new friends, finding their way around campus, meeting roommates and going kayaking.

During the second focus group, students were engaged in an activity to broaden this discussion to consider what they need to keep their engineering career in orbit, using the metaphor of planets circling the sun. Main themes that emerged from the discussion included academic skills and personal attitudes, professional connections, financial support, creating and maintaining a balanced life, dealing effectively with male dominance, and giving back to future RAMP students.

For the third focus group, students were given time to think silently about the question, "What is something that surprised you about RAMP?" Each student then shared their response with the group. Some students shared personal successes that were surprising to them, such as getting a good grade in Calculus. Students also reflected on their experience in RAMP as compared with their experience in high school, noting especially how greater opportunities in RAMP for

studying with friends helped to alleviate stress. Other aspects of the program students found surprising were stories told during the panel presentations regarding personal educational and career opportunities—especially “how they continued to grow and find new opportunities,” and new insights about the “many facets” of engineering careers gained on fieldtrips to industry sites.

#### ***4.2: 2018 Online Survey Responses***

For the final online survey, RAMP students were asked to rank aspects of the course on a scale from “not helpful” to “very helpful.” Aspects of the program considered most unhelpful were: Introduction to Engineering (31.25%), calculus support (26.67%), and focus groups (25%). Aspects of the program considered most helpful were: Calculus class (98.3%), studying with classmates (87.5%), industry visits (81.25%), and panel presentations (68.75%) (see Figure 2).

In addition, students were asked to respond to three additional open-ended questions. For the first question, “what do you feel could be improved about the RAMP program,” responses emphasized the following: 1) the daily program should be “shorter and more focused” with “more structure” and the whole day shouldn’t be spent in one classroom; 2) more hands-on projects should be included; 3) Introduction to Engineering should be reorganized to have a clearer structure and perhaps combined with another major-specific engineering course, and 4) “no more focus groups.” For the second question, “what was most challenging during the RAMP program,” the most common responses mentioned difficulties with coding, calculus, time management, and becoming tired from the long days. And for the third question, “what did you accomplish during RAMP that you are most proud of,” responses were diverse and included the following: finishing Calculus and receiving a good grade, transitioning from high school to college and making friends, connecting with women in industry, networking at engineering places and with professors and peers, improving communication skills, learning more about programming, and figuring out challenging engineering problems.

#### ***4.3: Changes made in the RAMP 2019 program based on RAMP 2018 Student Feedback***

##### ***1) From one faculty member focus group facilitator to two peer facilitators:***

In 2018, students expressed some dissatisfaction with the focus groups. On the survey, four students rated them as unhelpful, and when asked about how RAMP could be improved, one student commented “no more focus groups.” The faculty member facilitator also felt that given her lack of engineering background, she was unable to answer questions about engineering, and having facilitators with an engineering background would be helpful. In addition, students in 2018 mentioned they would like to connect with RAMP students in 2019 and provide mentoring and advice. Based on this feedback, we decided to train two peer facilitators for 2019. Both of these peer facilitators had completed the RAMP program in 2018, were studying in two different engineering majors, and were eager to interact with the next cohort. They were trained by the prior faculty researcher, and also received a stipend.

##### ***2) From long days in one classroom to a variety of locations***

During the focus groups and on the online survey, students objected to the long days in one classroom. In 2018, all of the RAMP classes and lunch panels were held in the same classroom. So in 2019, this was changed to blend some of their activities with another STEM summer



bridge program on campus (a.k.a. Launch), which allowed RAMP students to attend workshops at different locations.

3) *From presentation-based to more interactive research-based projects*

Students emphasized that they wanted more hands-on, projects, especially in Introduction to Engineering. So in 2019, RAMP faculty re-designed this course from one that was primarily focused on introducing programming skills and computing projects to a more research based hands-on activity. During the first three weeks all students explored six different research problems in interdisciplinary areas and in different faculty member research labs. At the beginning of the fourth week, six teams were formed and each team was assigned one of the six projects to expand on. Computing was built on top of this project-based activity and supported building simulation models and visualization of measurements made during the research.

4) *From graduate student mentors to undergraduates for project support*

Based on student feedback indicating the high value they placed on interacting with other engineering students, in 2019 the opportunity for RAMP students to interact with peer student mentors was increased. In 2018 two Ph.D students, both males who were accomplished in areas of robotics and computing were recruited for teaching portions of the Introduction to Engineering course. While the RAMP 2018 students clearly appreciated their knowledge, there was not much interaction between the graduate students outside of the lectures. In 2019, four young women who had participated in RAMP 2018 were recruited to support the RAMP 2019 students in a variety of ways, from informal conversations and social support to providing one-on-one Calculus tutoring. These near-peer mentors were able to engage the students in many ways within and outside the program activities. Demonstrating their appreciation and the strength of these positive connections, the RAMP 2019 students got together and organized a surprise birthday party for one of the peer mentors, with the entire group singing songs, dancing together and creating a few hours of a social activity on their own initiative.

In addition to these changes, several activities appreciated by students in RAMP 2018 were retained in RAMP 2019. For example, in the focus groups, students emphasized the need for balance, so we decided to keep some fun activities such as kayaking and ice-cream socials. The industry visits and panels were also rated highly in 2018, so these were included, and the final panel event was expanded to include research driven posters created by the students that were viewed by invitees from industry. Finally, in 2018 students had many questions about financial aid, and in response we brought in a representative from the Financial Aid office to talk with them. In 2019, we expanded this part of the program by connecting with the Launch program, a summer bridge for young men joining engineering in the Fall. This program offered financial wellness and financial aid workshops, as well as workshops on ethics, leadership, critical thinking, grit, and coop/internship opportunities. As a result of combining some of the RAMP and Launch programs, we observed that the RAMP 2019 group became more competitive with the Launch participants and created a more supportive network among themselves.

#### ***4.4: 2019 Focus Group Data Analysis***

##### *Student defined learning goals/aspirations for RAMP*

Similar to the 2018 first focus group, 2019 responses to the question, “what are you excited about learning/doing at RAMP,” emphasized academic, social, and professional skills and goals, within the overall theme of “getting a head start.” But a key difference was that students asked the peer facilitator to comment about her own experience in RAMP the previous year; this type of mentoring was not possible during 2018, because the facilitator was a social science faculty member. Some students were also interested to talk about issues/questions they had about the RAMP program thus far. Many of these issues were administrative in nature, such as how to get refunds for lunch vouchers, or how to interpret invoices, or suggestions about improvements for communication on the Slack discussion forum. Because the peer facilitators had dealt with many of these issues themselves, they were able to provide helpful responses. During this first focus group, students also commented on being a minority on their high school robotics team, with only white men as mentors, and how they appreciated the RAMP program being “just girls.”

For the second focus group topic, “how can you keep your engineering career in orbit,” in 2019, the interpretation of this question in each of the two focus groups was somewhat different. One of the groups focused especially on practical tips/suggestions to succeed academically, whereas the other group focused particularly on motivating factors. This may have been due to slight differences in how the question was phrased by each peer facilitator and particular follow-up questions used, as well as differences in the students in each focus group.

Similar to the responses in 2018, in the third focus group discussion students mentioned surprising personal successes such as getting good grades, but also mentioned more general achievements such as asking questions, being bold, being prepared, doing public speaking, and learning a lot of math. Students were surprised by the amount of coding and how many different skills they learned. They also voiced much appreciation for the RAMP Director, and valued her mentorship: “It’s really cool how she gets people to get excited about engineering, and not be so daunted by it. It’s really stigmatizing to be a woman in engineering, and she knows that and is helping us.” Some students also brought up new or additional areas they would like to explore, such as the environmental engineering program, the maker space, and the nuclear reactor on campus. One student responded that being allowed to come to the RAMP program in itself was surprising for her, because her parents were very strict.

After students had mentioned their comments about what was surprising, in one of the focus groups a student turned the question around and asked the peer facilitator, “What’s new and exciting to you?” The facilitator responded: “This year? I think what was exciting this year, was the research that I did. It’s stuff that I never thought I could do. I’ve never known about.” In the other group, a prolonged discussion ensued about how the 2019 RAMP program was similar or different from 2018, as well as tips for how to study more effectively and get involved with clubs/organizations such as Engineers without Borders.

In both of the focus groups, the presence of peer rather than faculty facilitators allowed students not only to share their own opinions and experiences more freely, but to learn from students who

experienced RAMP last year and are currently in engineering majors. This appeared to encourage a more meaningful and helpful sharing of information and advice.

#### ***4.5: 2019 Online Survey Responses***

In 2019, aspects of the program rated most unhelpful on the online survey were Introduction to Computing (14.28%), calculus support (14.28%), and focus groups (14.28%). Aspects of the program considered most helpful were one-on-one support from engineering faculty members (92.85%), industry visits (92.85%), industry panels on campus (78.57%), support from student assistants (78.57%), and studying with classmates (71.43%).

In 2019, in responding to the question, “what do you feel could be improved about the RAMP program,” several students mentioned mostly positive aspects: “I liked how there was always something new to do, keeps you on your toes,” and “I really enjoyed the RAMP program, I don’t think I would change much.”

Suggestions for improvement included learning more about other engineering majors; keeping the lunches as a break rather than scheduling panel discussions during this time; having more hands-on projects such as the circuit boards; considering shorter days, starting later in the morning, or no Friday classes, so students have more time to complete assignments and enjoy summer; providing an overview of the whole schedule so it’s easier to know what to expect each week; and offering more help with figuring out finances. Several students mentioned that the classes seemed very condensed, and one pointed out that making the RAMP program nine weeks long instead of six weeks might be helpful. Notably, two students mentioned that they felt greater awareness of students’ lack of background on different topics was needed.

Students also mentioned challenges such as difficulty with coding and calculus (especially adjusting to the fast pace and having less background in coding or calculus than one’s peers), focusing for long time periods, learning many topics in a short period of time, and balancing school and work. Additional challenges mentioned were more social/emotional in nature, and included handling social interactions in the dorm and feeling comfortable conversing with guests and panelists.

In response to the question about what they are most proud of, several students commented on achievements connected with coding, such as learning the basics of Python. Similar to 2018, other students mentioned getting good grades in Calculus, and one student pointed out she was proud that she understood Calculus “to the point where I could help others when they asked me questions.” Other academic achievements mentioned included finishing and presenting the final project, learning about circuits, sticking with the program, and “getting ahead and acclimated to campus.” Students also mentioned personal and/or emotional achievement they were proud of, such as becoming more confident talking with professors, or going outside their comfort zones. Finally, one student summarized her achievements as follows: “My biggest accomplishment was realizing who I am as a person and what will work best for me in college such as my study habits, social and friend groups, plans, my priorities”

*Open-ended survey questions about Focus Groups:*

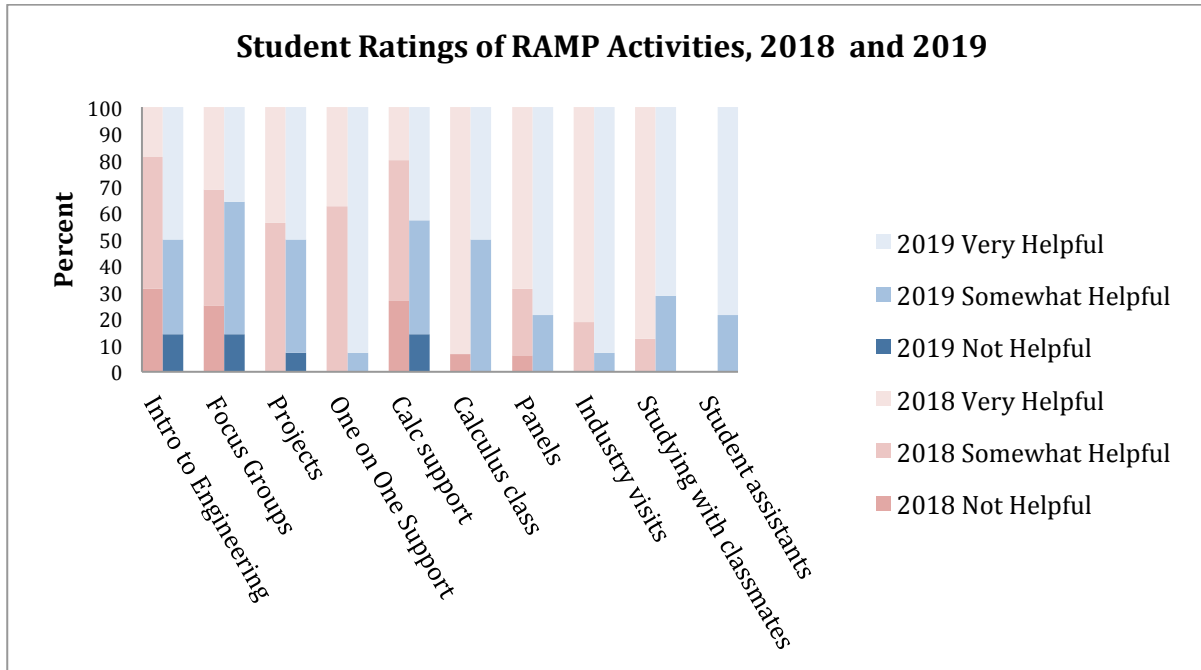
In 2019, we also asked students two open-ended questions about focus groups on the survey: “What did you like best about the focus groups?” and “What do you feel could be improved about the focus groups?” These questions were not asked in 2018.

In response to the first question: “what did you like best about the focus groups,” students appreciated the space to evaluate both themselves and the program. With regard to evaluating oneself, one student mentioned: “I liked that the topics were very reflective. It was nice to have time to look inward and check in with ourselves.” Another student noted the value of self-reflection and questioning, especially with regard to study habits: “The focus groups allowed me to think about my future in a more realistic point of view and made me really question my study habits and what I can do to improve them.” Students also appreciated the ability to connect with peers, hear their opinions, discuss topics they “were all passionate about,” and “learn about other women’s aspirations in life.” Finally, students noted that they were comfortable speaking openly in the focus groups, and valued the “safe space” to give feedback about the RAMP program “throughout the program and not just at the end.” The small size of the focus groups was mentioned as being especially conducive “. . . to not only get your own thoughts across, but also to listen to what other people have to say.”

For the second question, “what do you feel could be improved about the focus groups,” five students mentioned “nothing” or had no suggestions for improvement. In the words of one student: “I like how it is . . . sometimes when there’s problems we talk and figure out ways to solve them.” Suggestions for improvement included focusing more on short-term goals that students could accomplish between focus group meetings, offering a meditation session and discussion about how to realistically achieve future aspirations, less activity and more conversation, changing the time – “it was hard to focus and eat sometimes,” including more specific details about RAMP, and holding the focus groups every week instead of bi-weekly. One student commented that “sometimes things felt a bit forced,” and another that some of the activities (such as using the rocks/gemstones as prompts or the sticky notes in the tree values exercise) were not helpful –just talking would have been better. Only one student felt she would rather not have had the focus groups, and this was because she described herself as “pretty introverted” and needed time to decompress and catch up on studying during the lunch break.

In summary, Figure 2 (see below) compares the responses from the 2018 and 2019 group of participants to the survey questions. It shows the decrease in the ‘not helpful’ response from 2018 to 2019 when program changes were made for the Intro to Engineering course, focus groups, and Calculus support. The focus groups generally had higher ratings in 2019. The integration of support activities from student assistants was new in 2019 and was found to be very helpful by over 75% of the RAMP participants.

**Figure 2:** Comparing student ratings of RAMP activities for 2018 and 2019



#### ***4.6: Proposed Changes for RAMP 2020 based on RAMP 2019 Student Feedback***

Suggestions offered by students such as not having focus groups during lunch breaks, having weekly instead of bi-weekly meetings, concentrating on short term goals, and including meditation, are all possibilities that will be considered for 2020. Focusing on short term goals, in particular, would also help students develop clear “action steps” they can implement to help achieve better study habits, higher grades, easier social interactions, and other factors students mentioned were important to them.

Peer focus group facilitators will be continued in 2020, due to their successful participation in 2019. We also plan to include these facilitators in the design and analysis of the focus groups, to increase student participation in the research process. Additional areas we will consider addressing in 2020 include incorporating greater awareness of students’ lack of background on topics (especially circuits and coding) into course and project instructions, providing a more explicit overview of the whole RAMP schedule so students know what to expect, having students spend more time exploring different engineering majors, having shorter days or starting later in the morning, exposing students to a variety of social interactions (i.e., panelists, industry partners, faculty, etc.) to help overcome social anxiety and build confidence, offering help with navigating financial aid, and including a variety of options for interactions with teaching assistants and mentors. With proposed virtual interaction in 2020, there is a greater degree of flexibility to address the needs of individual students, while still focusing on the overall goal of building a networked community and increasing the students’ sense of belonging and preparedness for education and careers in engineering.

#### **4.0 Discussion/Conclusion**

Our implementation and analysis of PAR focus groups and surveys as a formative assessment during the RAMP summer program suggests that this approach benefits students by providing a safe space for reflexive discussion, problem-solving, peer mentorship, and program feedback. Simultaneously, this approach also benefits faculty, by allowing insight into students' perceptions, experiences, and specific suggestions for program improvement.

By listening to student voices and concerns, we were able to achieve higher student ratings on almost all key program components, especially on the redesign of the Introduction to Engineering course, one-on-one support, and Calculus support, as shown in Figure 1. Student appreciation of the PAR focus groups also improved based on their feedback, with the inclusion of peer facilitators in 2019. In the focus groups, students were comfortable expressing vulnerability and discussing limitations in their own backgrounds (such as lack of exposure to coding, coming from disadvantaged school districts, etc.) Creating such psychologically safe spaces has been also noted by researchers at Google as the most important characteristic for building effective teams [24].

Limitations of our study thus far include the absence of a control group of female engineering students who did not participate in the RAMP program and the lack of longitudinal data tracking the effects of previous summer programs on female students' achievements over time with measures such as GPAs and retention/graduation rates. Without such data, we cannot make any generalizations regarding the effectiveness of PAR strategies or their association with program improvement or the retention and success of women in engineering majors and careers. However, we have begun to collect relevant data on RAMP program participants to support our analyses in successive years. This includes the results of surveys administered during each semester of their study as well as data from at least one focus group conducted each semester that will include all past RAMP participants.

In the future, we intend to survey engineering students who did not participate in RAMP as well as those who did to compare perceptions and experiences, and also track retention/graduation rates over at least a five-year period. Extending this study beyond graduation to look at career choices and graduate study will also be considered. We also propose to increase student involvement in the research design and data analysis process, and continue involving students as peer-facilitators. Finally, looking closely at variables that might affect student success such as socioeconomic class, family support, high school preparation, race/ethnic background, and social networks, and using this information to create a supportive, beneficial environment for all engineering students through all stages of their academic careers is a goal as we continue this research.

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