Materials Connection REU Site (MacREU R'Side) Evaluation, 2017*

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Abstract

This is the evaluation for the fourth year of the MacREU-UCR REU site. As it has in each of the past years, the program performed very well in exposing students to science and engineering, building their scientific skills and encouraging them to pursue a PhD. As we report in the first year's evaluation (2014), the program's first year had a number of organizational challenges; virtually all of these challenges were overcome in 2015 and the second and their year evaluations of the program showed that the students gained considerable research skills and professional development that year in every respect we measured. This evaluation shows that on every measure, the 2017 program equaled or exceeded the already very strong results of the previous years. In particular, the program maintained high levels of exposure to research and mentoring, and also showed significant improvements in the program's on-campus administration and students' experience.

1 Introduction

"Materials Connection REU" (MacREU R'Side) was a 10 week REU site, held in the summer of 2017, in which XXX undergraduate students, mostly from Southern California colleges, had the opportunity to conduct research in science and engineering labs on the UCR campus. The students came from demographic groups that are under-represented in STEM fields, and were carefully selected among applicants as those who were at risk of not pursuing a career in science. The students home institutions are XXX.

All of the students' research projects were related to the growth and application of thin films or monolayer materials. Students were placed in a variety of labs within the Materials Science and Engineering program. Participants are exposed to a wide area of fields from catalytic chemistry to semiconductor processing and from solar cell manufacture to the improvement of medical devices. To learn more about the MacREU site at UCR, visit http://macreu.ucr.edu/. At this site, one can view short video presentations from each of the students that describes their research and experience in the program. [XXX important note: this website was not updated last summer and so it doesn't have the photo, student names, or links to videos XXX.]

This evaluation draws on two data sources 1) a survey of participating students based on the REU survey template available on the "Student Assessment of Learning Goals" website http://salgsite.org, providing both qualitative and quantitative evaluation data, and 2) qualitative responses from the participating students provided via email and in open-ended responses in the survey itself.

Overall, the fourth year of the program well met its academic goals of exposing students to research, building their academic research skills, and gaining their interest in pursuing science and engineering as a career at the PhD level. In every measure in this evaluation, the 2017 program equaled or exceeded the extremely strong results we observed from the previous three years of the program. In sum, the program was a strong success and met its goals of instilling an interest in science and engineering among students from under-represented backgrounds. In particular, the program maintained high levels of exposure to research and mentoring, and also showed significant improvements in the program's on-campus administration and students' experience.

2 Student Assessment of Learning Goals Survey Results

In this section, we present the results of a survey we administered to the XXX participating students, and 15 of these students filled out a survey. The survey comes from a template for REU evaluations available at the Student Assessment of Learning Goals website.[1] We used this website to administer the survey and to generate the figures showing results.

Overall, the program well met its goals of introducing students to scientific research as a career and helping them to build capacity for conducting scientific research. This can be seen for example in Figure 1. In this section of the survey, students were asked to rate

[1] See https://salgsite.net/, accessed February 9, 2018.

Gains in THINKING AND WORKING LIKE A SCIENTIST: APPLICATION OF KNOWLEDGE TO RESEARCH WORK.

1. How much did you GAIN in the following areas as a result of your most recent research experience?	1:no gains	2:a little gain	3:moderate gain	4:good gain	5:great gain	9:not applicable	Mean	N
1.1 Analyzing data for patterns.	0%	0%	20%	13%	67%	0%	4.5	15
1.2 Figuring out the next step in a research project.	0%	7%	27%	13%	53%	0%	4.1	15
1.3 Problem-solving in general.	0%	0%	13%	40%	47%	0%	4.3	15
1.4 Formulating a research question that could be answered with data.	0%	20%	13%	7%	60%	0%	4.1	15
1.5 Identifying limitations of research methods and designs.	0%	0%	7%	33%	53%	7%	4.5	14
1.6 Understanding the theory and concepts guiding my research project.	0%	0%	0%	40%	60%	0%	4.6	15
1.7 Understanding the connections among scientific disciplines.	0%	7%	7%	13%	67%	7%	4.5	14
1.8 Understanding the relevance of research to my coursework.	0%	7%	7%	20%	67%	0%	4.5	15

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

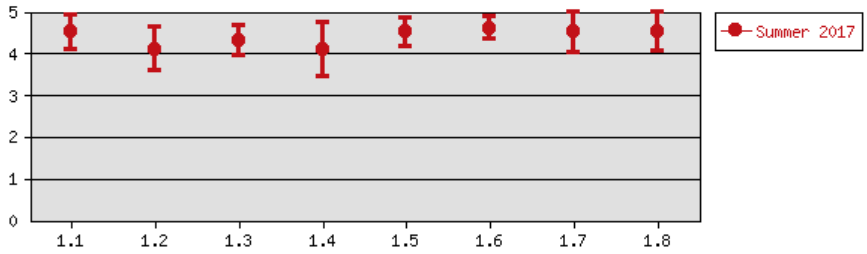

Figure 1: Gains in Thinking and Working Like a Scientist

their own gains from the program in learning how to think scientifically and work like a scientist, and to apply scientific knowledge to research. On average, students report good to great gains in skills such as analyzing data for patterns, formulating a research question and understanding theory and concepts. while there is a little variability in responses, virtually all students report great gains in developing this capacity such that each of the confidence intervals exceeds the good category. This shows an improvement compared to year 1's responses on these items, in which many of the confidence intervals overlapped the good category. The results for 2017 are similar to the results we observed in 2016, although there appears to be a bit lower statistical confidence on items 1.2, "Figuring out the next steps in a research project," and 1.4, "Formulating a research question that could be answered with data." In each case the confidence intervals overlap between the two years.

Likewise, in figure 2 students reported considerable personal gains in their own capacity to do research, in areas such as their own ability to contribute to science, their confidence to do well in future science courses, and understanding what everyday research is like. Like in Figure 1, in no case did a confidence interval around a question mean include only a good level of gain response, and again showing an improvement over year 1. The results

PERSONAL GAINS RELATED TO RESEARCH WORK

2. How much did you GAIN in the following areas as a result of your most recent research experience?	1:no gains	2:a little gain	3:moderate gain	4:good gain	5:great gain	9:not applicable	Mean	N
2.1 Confidence in my ability to contribute to science.	0%	7%	7%	33%	53%	0%	4.3	15
2.2 Comfort in discussing scientific concepts with others.	0%	7%	27%	13%	53%	0%	4.1	15
2.3 Comfort in working collaboratively with others.	0%	0%	20%	27%	53%	0%	4.3	15
2.4 Confidence in my ability to do well in future science courses.	0%	0%	7%	27%	67%	0%	4.6	15
2.5 Ability to work independently.	0%	0%	13%	33%	53%	0%	4.4	15
2.6 Developing patience with the slow pace of research.	0%	7%	7%	20%	67%	0%	4.5	15
2.7 Understanding what everyday research work is like.	0%	0%	7%	7%	87%	0%	4.8	15
2.8 Taking greater care in conducting procedures in the lab or field.	0%	0%	7%	20%	73%	0%	4.7	15

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

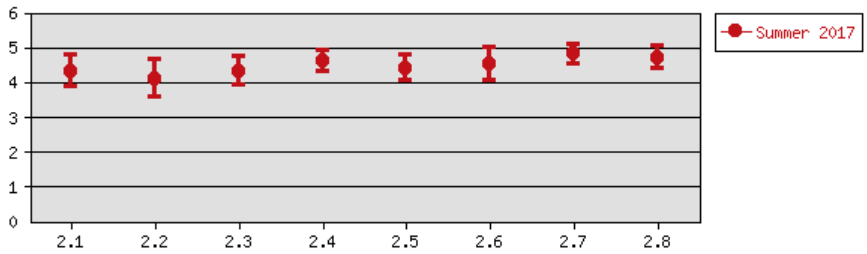

Figure 2: Personal Gains Related to Research Work

from 2017 are nearly identical to those in 2016.

Figure 3 also presents considerable evidence that students improved their professional skills such as how to prepare a scientific poster, keeping a detailed lab notebook and understanding journal articles. Students tend to report good gains in these skills across the board, similar to the results in 2016, but with a bit more precision and higher point estimates for items 3.6, "Keeping a detailed lab notebook," 3.7 "Conducting observations in the lab or field," 3.8 "Using statistics to analyze data," and 3.11 "Understanding journal articles."

Figure 4 continues to support the view that students gained in their self-efficacy for conducting research, where students typically indicated their gained a fair amount or a great deal in their own feelings of efficacy in engaging in real-world science research, feelings of responsibility for their research project, feeling part of the scientific community, confidence in their own ability to try out new ideas or procedures on their own and interacting with scientists from outside of the school. Again these results are nearly identical to those in 2016.

Overall, identical to the results in 2016, students rated the quality of their research experience as very good, including their working relationships with their research mentor, the amount of time doing meaningful research and the overall experience, and the amount of time spent with their mentors and getting advice from their mentors about graduate

Gains in SKILLS

3. How much did you GAIN in the following areas as a result of your most recent research experience?	1:no gains	2:a little gain	3:moderate gain	4:good gain	5:great gain	9:not applicable	Mean	N
3.1 Writing scientific reports or papers.	0%	13%	20%	13%	33%	20%	3.8	12
3.2 Making oral presentations.	0%	0%	13%	33%	53%	0%	4.4	15
3.3 Defending an argument when asked questions.	0%	0%	33%	47%	20%	0%	3.9	15
3.4 Explaining my project to people outside my field.	0%	0%	13%	33%	53%	0%	4.4	15
3.5 Preparing a scientific poster.	0%	0%	0%	27%	73%	0%	4.7	15
3.6 Keeping a detailed lab notebook.	0%	7%	0%	27%	60%	7%	4.5	14
3.7 Conducting observations in the lab or field.	0%	0%	20%	20%	53%	7%	4.4	14
3.8 Using statistics to analyze data.	0%	0%	27%	27%	27%	20%	4.0	12
3.9 Calibrating instruments needed for measurement.	0%	0%	33%	27%	40%	0%	4.1	15
3.10 Working with computers.	0%	7%	20%	40%	27%	7%	3.9	14
3.11 Understanding journal articles.	0%	0%	7%	40%	53%	0%	4.5	15
3.12 Conducting database or internet searches.	0%	13%	7%	27%	53%	0%	4.2	15
3.13 Managing my time.	0%	0%	20%	40%	40%	0%	4.2	15

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

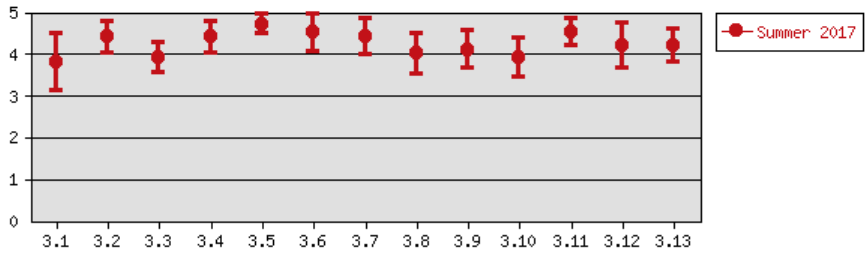

Figure 3: Gains in Academic Skills

schools. (note that the responses are so positive that the software extends the scale of the Y axis to 6, even though the highest possible response is a 5). The questionnaire also give students an opportunity to add more thoughts on the quality of their research experience and they wrote as follows.

- My mentor, [mentor's name], was amazing. He was very patient with me as I consistently asked several questions. I owe my great experience in the REU to him. Very wise as well.
- It felt a bit like a trial by fire at first but made it that much more fulfilling overcoming the obstacles.
- I really enjoyed the time and dedication that my mentor [mentor's name], put into getting me to understand my project. He didn't tell me what to do, he pointed me in the right direction so as to find good information. If I didn't understand something I felt comfortable asking and he would take the time to explain. Excellent mentor, and great advisor.

The following questions ask about your overall research experience and about any changes in your attitudes or behaviors as a researcher.

4. During your research experience HOW MUCH did you:	1:none	2:a little	3:some	4:a fair amount	5:a great deal	9:not applicable	Mean	N
4.1 Engage in real-world science research	0%	0%	0%	27%	73%	0%	4.7	15
4.2 Feel like a scientist.	0%	0%	0%	7%	93%	0%	4.9	15
4.3 Think creatively about the project.	0%	0%	20%	40%	40%	0%	4.2	15
4.4 Try out new ideas or procedures on your own.	0%	7%	20%	27%	47%	0%	4.1	15
4.5 Feel responsible for the project.	0%	0%	7%	13%	80%	0%	4.7	15
4.6 Work extra hours because you were excited about the research.	0%	0%	0%	40%	60%	0%	4.6	15
4.7 Interact with scientists from outside your school.	7%	0%	20%	0%	67%	7%	4.3	14
4.8 Feel a part of a scientific community.	0%	0%	7%	20%	73%	0%	4.7	15

Summary of scale results

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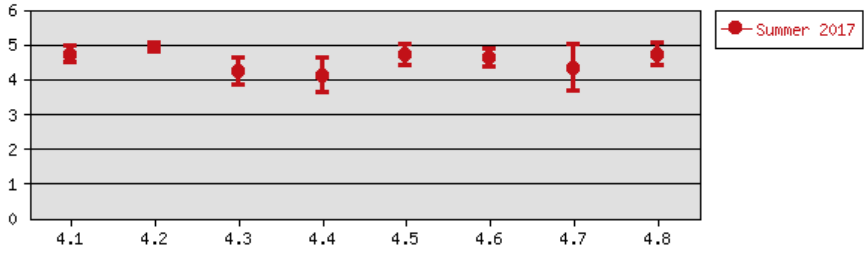

Figure 4: Attitude and Behavioral Changes

- My mentor provided me with invaluable information and experience in the lab. He took the time to teach me and gave me great insight into the life of a grad student.
- Everything was great!
- My mentor was extremely helpful and great about giving advice. If I had any questions he was willing to answer them.
- Overall, I highly enjoyed working in a laboratory setting. My mentor and lab-mates were helpful, and my P.I. was always available if I needed clarification.
- I was alone 90 percent of the time but [the grad student mentor] was still a good mentor the 10 percent of the time he was with me.

Figure 6 summarizes the research communication activities students participated in. The program expected students to prepare a scientific poster as a part of the program, and most of them indicated that they either presented the poster or planned to present it. The program did provide students an opportunity to prepare a talk, but they did not have the opportunity to attend a conference or publish a paper during the summer session, but the large majority plan to do these activities subsequently.

These questions ask about your research experience.

5. Please rate the following:	1:Not applicable	2:Poor	3:Fair	4:Good	5:Excellent	:	Mean	N
5.1 My working relationship with my research mentor	0%	7%	13%	20%	60%		4.3	15
5.2 My working relationship with research group members.	0%	7%	7%	20%	67%		4.5	15
5.3 The amount of time I spent doing meaningful research.	0%	0%	13%	33%	53%		4.4	15
5.4 The amount of time I spent with my research mentor.	0%	20%	7%	20%	53%		4.1	15
5.5 The advice my research mentor provided about careers or graduate school.	7%	0%	20%	27%	47%		4.1	15
5.6 The research experience overall.	0%	0%	7%	20%	73%		4.7	15
5.7 Please comment on any of these aspects.	Enter codes for text answers						--	8

Summary of scale results

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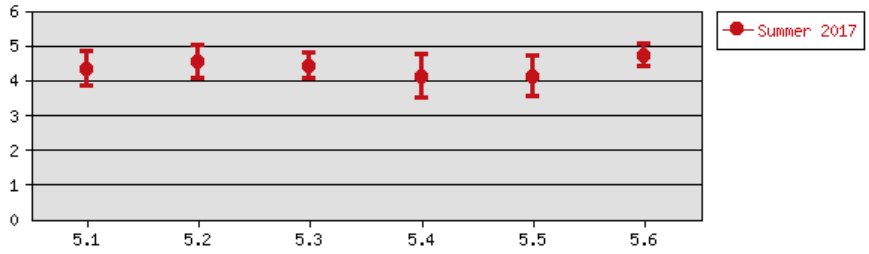

Figure 5: Quality of Research Experience

Figure 7 continues to lend support to our belief that the program enhanced students' interest in science and engineering as a career, typically indicating that the program confirmed and clarified their scientific career interests. Compared to 2016, we observe a significant increase in items 7.1 "Doing research confirmed my interest in my field of study," (by 27 percent) and 7.2 "Doing research clarified for me which field of study I want to pursue" (by 37 percent).

Figure 8 also confirms that the program enhanced students' expectations and interests in pursuing research and science as a career, indicating gains in interest in enrolling in a STEM PhD or masters' program and working in a science lab. The program did not enhance students' interest in medical, dental or law school which is expected. This figure overall indicates both the effectiveness of the program in enhancing students' interest in science and also that the program did not typically select students already on the science track, since if students entered program on a science career track they also would have indicated no gains. These results are identical to those in 2016.

The questionnaire also asked them to type in their intended degree and, "compared to your intentions BEFORE doing research, HOW LIKELY YOU ARE NOW to enroll in a graduate program leading to an advanced degree."

- The REU really opened my eyes to subjects I had never heard of, which supported my hunger as a engineer, something I had felt had disappeared.

Research experience

6. As part of my most recent research experience...	1:yes	2:no	:	:	:	:	Mean	N
6.1 I presented a talk or poster to other students or faculty	93%	7%					--	15
6.2 I presented a talk or poster at a professional conference	13%	87%					--	15
6.3 I attended a conference	20%	80%					--	15
6.4 I wrote or co-wrote a paper that was published in an academic journal	7%	93%					--	15
6.5 I wrote or co-wrote a paper that was published in an undergraduate research journal	7%	93%					--	15
6.6 I will present a talk or poster to other students and faculty	87%	13%					--	15
6.7 I will present a talk or poster at a professional conference	87%	13%					--	15
6.8 I will write or co-write a paper to be published in an academic journal.	40%	60%					--	15
6.9 I will write or co-write a paper to be published in an undergraduate research journal.	27%	73%					--	15
6.10 I won an award or scholarship based on my research	7%	93%					--	15

Figure 6: Research Activities

- Mechanical Engineering. Somewhat more likely.
- B.S. in Chemistry. I was undecided but interested in pursuing an graduate degree before the program. After a taste of graduate work and life I am convinced that I would like to go on to grad school, circumstances allowing.
- I wanted to pursue a masters degree in Aerospace Engineering. Seeing the opportunities that material science brings to that field, I would like to pursue a Phd in material science to further my ability to perform. Receiving a Phd is on my to do list.
- I intend to go to graduate school to pursue a PhD in environmental engineering. Before the program, I was completely unsure if grad school was the right option for me, but I am much more likely to enroll in a PhD program now.
- I intend to obtain my Ph.D. I knew I wanted to before doing research, but after doing research, it affirmed my decision.
- I want to obtain a PhD in physical chemistry or organic chemistry. I will definitely go to graduate school.
- I have always intended to go to grad school, but I had my doubts and some fears. However, this program has helped me gain more confidence in my desire to go to grad school and more confidence in my abilities.

Research experience

7. Rate how much you agree with the following statements.	1:Strongly disagree	2:Disagree	3:Agree	4:Strongly agree	Mean	N
7.1 Doing research confirmed my interest in my field of study.	7%	0%	27%	67%	3.5	15
7.2 Doing research clarified for me which field of study I want to pursue.	0%	0%	27%	73%	3.7	15
7.3 My research experience has prepared me for advanced coursework or thesis work	0%	7%	47%	47%	3.4	15
7.4 My research experience has prepared me for graduate school.	0%	0%	47%	53%	3.5	15
7.5 My research experience has prepared me for a job.	7%	13%	47%	33%	3.1	15

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

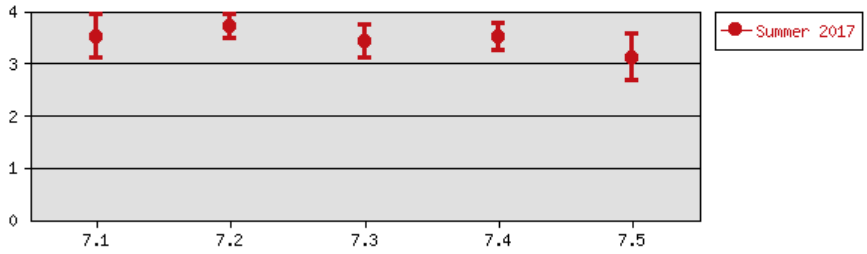

Figure 7: Effects of Research Experience on Personal Advancement

- Prior to participating in MacREU, I was already interested in attending graduate school, but I was unsure if i wanted to pursue a PhD or an MD. After the program, I resolved that I will pursue an MD/PhD program.
- My intended degree was Aerospace Engineering with only a bachelors. Now, I am considering doing graduate level work and obtaining a Masters.
- Before I was not sure if I wanted to pursue a masters degree but now I am more willing to do so.
- I will enroll in a Masters or PhD program after completing my undergrad degree.

The questionnaire included an open-ended question asking students to reflect on how their research experience influence their own thinking about future career and graduate school plans. The students wrote,

- I find myself wanting to pursue a degree in material science and engineering based on the various experiments I was exposed to.
- The research experience allowed me to live life of a graduate student for 10 weeks, meeting and learning from graduate students about how to get into a PhD program and what it's like to be a PhD student.
- Graduate school is the goal

Research experience

8. Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:	1:not more likely	2:a little more likely	3:somewhat more likely	4:much more likely	5:extremely more likely	9:not applicable	Mean	N
8.1 enroll in a Ph.D. program in science, mathematics or engineering?	0%	7%	7%	40%	47%	0%	4.3	15
8.2 enroll in a masters program in science, mathematics or engineering?	20%	0%	20%	20%	33%	7%	3.5	14
8.3 enroll in a combined M.D/Ph.D program	33%	7%	7%	20%	33%	0%	3.1	15
8.4 enroll in medical or dental school?	53%	7%	7%	7%	0%	27%	1.5	11
8.5 enroll in a program to earn a different professional degree (i.e. law, veterinary medicine, etc.)	67%	7%	7%	7%	0%	13%	1.5	13
8.6 pursue certification as a teacher?	33%	20%	20%	13%	7%	7%	2.4	14
8.7 work in a science lab?	0%	13%	27%	27%	33%	0%	3.8	15
8.8 Other. Please state your intended degree and, compared to your intentions BEFORE doing research, HOW LIKELY YOU ARE NOW to enroll in a graduate program leading to an advanced degree.	Enter codes for text answers						--	12

Summary of scale results

The graphic below lists the mean and confidence interval (±3 times the standard error) for each item.

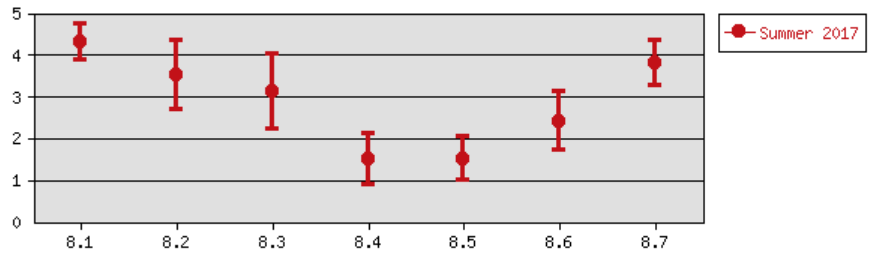

Figure 8: Effect of Experience on Entering the Pipeline

- I was interested in grad school but was apprehensive not having a clear notion of what demands would be expected. This program greatly helped alleviate those fears and boosted my confidence in being able to shoulder the demands and be successful in grad school.
- Doing research this summer, gave me a glimpse for what to expect when I start working in a laboratory. Doing research with other graduate students gave me an idea of what paths to follow and helped me define what choices to make.
- The research program stimulated my thinking about graduate school. I got to see first hand what the life of a graduate student is like and ask my mentor all of the previously unanswered questions that I had. The experience also helped me realize that I want to go into the environmental engineering field to focus on sustainable technologies.
- It gave me idea as to what to expect during graduate school. It helped me figure out just what I wanted to get my Ph.D in. Before this program, I knew I wanted to get my Ph.D, but I did not know what I wanted to get it in.

- It helped give me an idea of what research was like at a graduate level. I had to overcome problems by researching and analyzing the situation first.
- I feel more certain that I want to be a scientists and that grad school, along with some experience in industry, is the route for me.
- My research experience helped me in identifying which areas I need more work in before applying to graduate school, and that I should seek out an advisor who's research I am interested in.
- My research experience made me strongly consider applying for graduate school, as I have been able to see just how graduate life is.
- The research experience influenced me to apply to graduate programs and it helped me become a more confident applicant.
- It is helping me decide whether or not I want to go to graduate school first or work in industry first.
- I enjoyed the research experience offered by MAC REU so much that i have considered applying to UCR for grad school so that I may once again work in the Yadong Yin Lab.

The questionnaire also asked students to reflect on other ways the program enhanced their interest in science as a career and led to personal gains, and they wrote,

- I also gain connections with other graduate students in my lab and other undergrad students from the program, who are future scientists and engineers. I also met part time grad students who are currently working at engineering firms and learned so much from them about working in an industry.
- Productive friendships
- It was a also a great experience to literally move so far away from my comfort zone. To have to adapt to a new daily environment away from my creature comforts for 10 weeks in a fun but high demand program, forced me to improve my personal routine and organization. In order to keep up the pace I had to improve my sleep schedule, diet, exercise, and find a balance between my personal, social, and profession(research) life so that I was productive without getting burnt out.
- One of the biggest gains came from being able to think about how to carry out my experiments. The challenge of replicating an experiment became a great challenge but it encouraged me to do further research.
- The professional and personal connections that are made through the MacREU program are invaluable. I was able to connect with professors, graduate students, deans, and fellow program participants in my field and in others that I would otherwise never have been able to meet.

- I gained a preview of what grad school is like and how different a lab class is from doing actual research.
- Thanks to my participation in this program, my P.I. has offered me a place in their lab if I decide to transfer to UCR.
- This research experience helped me improve my communication skills by being able to speak and explain things more clearly to professors and graduate students.
- Great networking
- I have gained in my ability to sit myself down and get to work even though I would want to be outside.

The following questions ask about aspects of the research program.

11. How satisfied were you with the following aspects of the research program?	1:Not applicable.	2:Very dissatisfied	3:Somewhat dissatisfied	4:Somewhat satisfied	5:Very satisfied	Mean	N
11.1 The application process.	0%	0%	0%	47%	53%	--	15
11.2 Support and guidance from program staff.	0%	0%	0%	20%	80%	--	15
11.3 Support and guidance from my research mentor.	0%	13%	0%	20%	67%	--	15
11.4 Support and guidance from other research group members.	0%	0%	0%	20%	80%	--	15
11.5 Research group meetings.	13%	7%	7%	20%	53%	--	15
11.6 Financial support.	0%	0%	7%	27%	67%	--	15
11.7 Group social activities.	0%	7%	0%	20%	73%	--	15

Figure 9: Satisfaction with the Program

Figure 9 indicates that students overall were satisfied with the organization and structure of the program itself. These scores are a strong improvement over the first year's evaluation, in which students gave relatively low marks to support and guidance from the program staff, few research group meetings and lack of social activities. We readily admit that the first year of the program was a learning experience for the PIs and we took care to work with the program staff to improve the program. In particular, we included better training and involvement with lab personnel; we hired a staff person (Velveth Klee) who was able to provide constant attention to the group training and activities, and more planned social activities. Overall we see even more gains in the highest level of satisfaction over the positive responses we observed in 2016, especially on items 11.1 "The application process" (by 18 percent), 11.2 "Support and guidance from program staff" (by 35 percent), 11.4 "Support and guidance from other research group members" (by 10 percent), 11.6 "Financial support" (by 18 percent), and 11.7 "Group social activities" (by 23 percent).

Figure 10 also indicates mixed views of the training offered, although in each case students typically report gaining a good amount or a great deal of learning from each program element. This might be an area for future improvement, although there is only

Training Sessions

12. How MUCH did the following activities support your learning?	1:Did not do this activity	2:Not at all	3:A little	4:A good amount	5:A great deal	Mean	N
12.1 Workshop(s)on science writing and presentation.	13%	0%	20%	20%	47%	--	15
12.2 Training in library/internet/database search methods.	7%	27%	40%	13%	13%	--	15
12.3 Safety training	0%	0%	20%	53%	27%	--	15
12.4 Ethics seminar(s)	47%	0%	33%	7%	13%	--	15
12.5 Training in human or animal subjects regulations.	60%	0%	20%	7%	13%	--	15

Figure 10: Gains from Professional Training

so much training students can do over the course of a 10 week program. We did observe a significant increase in the top response over 2016 on item 12.1 "Workshop(s)on science writing and presentation" (by 37 percent).

How did you find out about research opportunities on campus?

14. I found out about research opportunities from:	1:yes	2:no	Mean	N
14.1 I knew this institution offered research opportunities to undergraduates before coming here	60%	40%	--	15
14.2 in class	33%	67%	--	15
14.3 an academic advisor	60%	40%	--	15
14.4 an announcement (flyer, poster, email, website, etc.)	47%	53%	--	15
14.5 a presentation given by professors or students about their research	27%	73%	--	15
14.6 Other (please specify):	Enter codes for text answers		--	6

Figure 11: Ways to Learn about Research Opportunities on Campus

Figure 11 indicates that students learn about research opportunities such as MacREU from a variety of sources. Here we observe significant increases across the board in a positive response over 2016 on items 14.1 "I knew this institution offered research opportunities to undergraduates before coming here" (by 50 percent), item 14.2 "In class" (by 33 percent), 14.3 "An academic advisor" (by 40 percent), and 14.5 "A presentation given by professors or students about their research" (by 22 percent). These results clearly show a strong improvement in the advertising, publicizing and communication of the program to prospective students.

Students also indicated other sources for this information in an open ended question, including two that learned of the program from the previous year's participants:

- From a former MacREU student
- My PI mentioned it to me
- I spoke with another student about the program and asked for further information from my professor.

- A friend of mine did this program last summer.
- My professor knew a student had done the program a previous year, so he encouraged me to apply.
- My current PI

What motivated you to do research?

15. I WANTED TO DO RESEARCH TO: (select all that apply)	1:yes	2:no	Mean	N
15.1 explore my interest in science	93%	7%	--	15
15.2 gain hands-on experience in research	100%	0%	--	15
15.3 clarify which field I wanted to study	73%	27%	--	15
15.4 clarify whether graduate school would be a good choice for me	93%	7%	--	15
15.5 clarify whether I wanted to pursue a science research career	80%	20%	--	15
15.6 have a good intellectual challenge	100%	0%	--	15
15.7 work more closely with a particular faculty member	53%	47%	--	15
15.8 participate in a program with strong reputation	87%	13%	--	15
15.9 get good letters of recommendation	80%	20%	--	15
15.10 enhance my resume	93%	7%	--	15
15.11 Other (please specify)	Enter codes for text answers		--	1

Figure 12: Motivations to do research

Figure 12 shows that students report a wide range of motivations for participating in research. Here we also see a significant increase over 2016 in a "Yes" response on items 15.6 "Have a good intellectual challenge" (by 20 percent), 15.7 "Work more closely with a particular faculty member" (by 18 percent), 15.8 "Participate in a program with strong reputation" (by 47 percent), 15.9 "Get good letters of recommendation" (by 35 percent), and 15.10 "Enhance my resume" (by 18 percent).

The questionnaire also provided students an open-ended question to report motivations they have to do research. Only one student responded to this, who wrote "I also wanted to do this to prove that I could handle the load of being in an academic research environment."

Students were also given the opportunity to reflect on how the program impacted their career plans, and they wrote as follows. Typically the responses were quite positive although we do note some suggestions.

- The information that was given in the session answered a lot of questions which helped alleviate a lot of my previously stated apprehension toward graduate school
- The information session about applying to the graduate program at UCR was very helpful. The details about G.R.E, fellowships, and requirements for applying gave a good idea on what to do and what steps to follow. The talks from Dr. Mathaudhu,

Dean Uhrich, Dr. Kisailus, and Provost Larive, were very inspirational and relatable and would definitely say that these are one of the best parts of the program.

- There should be more of these sessions with one in particular that would give us the chance to make a list of our top graduate schools and have help figuring out what is required to apply to those schools.
- Participating in the GRE training sessions has raised my confidence in my ability to earn a high score.
- Because of the MacREU program, it has helped me become a confident applicant to graduate schools. Before the program, I was not even thinking about graduate school, now it is something that I want to do.
- Dean Esterling's talk on grad school is what sold grad school for me.

Students also were given an opportunity to write suggestions on how to make the program experience better.

- I feel students were limited to the hours they worked by having to walk back to the dorms at dusk, so free parking would of eliminated such discrepancy.
- Better planning with mentors
- Training for applicable instruments
- Perhaps a clearer initial direction in the project although I believe this was more due to specific circumstances rather than a mishandling of anything. I was very unfamiliar with actual research and it was my mentor's first time working with this program. He had just finished his own project that he had been working on for the past year. The paper he wrote for it got published a week into my program. So he was a bit unclear himself of the direction he wanted to go. Our initial expectations of each other's roles and how things were supposed to work during the summer were grossly miscalculated. However he was extremely patient did and did an excellent job guiding me. We figured things out and formed an excellent personal and professional relationship.
- It would've been useful to have a list of trainings specific to the lab that was going to be used. And be trained on those skills first.
- The research experience was perfect.
- More down time in the lab.
- If sessions and trainings were at better times and more organized.
- I would have enjoyed my experience more, if the program had a wider range of labs we could have worked in.
- A brief background of the lab, mentors, PI, and lab culture before entering in a lab.

- My research experience was as good as it can get. I cannot think of anything that would make my research experience better.
- More speaker sessions.
- Learning to speak Mandarin would have been essential in my lab since it is an all Chinese lab.

And students were asked an open-ended question on how to make the experience better overall.

- Free parking
- Regular check-ups on mentors and students to keep track and ensure that everything goes well and that students are actually learning and doing meaningful research.
- I would say the living situation could have been better. I personally had relatively few problems but was witness to several incidences that could have, and I believe, should have been avoided. From filthy initial accommodations (trash and food), roaches and ants, to not having parking permits for the residence hall parking lot which lead to two vehicle break-ins because we had to park on the street which was much less patrolled.
- I personally would've liked to be able to access the SEM microscope on my own. I understood that my mentor did what he could for us to take images on the SEM but I would've liked to have independent access. I would've also liked to have access to the Machine Shop tools, and would've liked to have some formal training in there.
- The program would have been better if the participants would have been able to stay in housing that was closer to the buildings that we were doing research in and if we had UCR student IDs.
- More organized fun activities.
- More organized social event.
- An equal focus on all areas of the GRE would have been more helpful, rather than focusing on vocabulary.
- Pre-screening the individual labs more carefully to see if they are truly suited for undergraduates.
- I cannot think of any ideas that would improve the program. Overall, the program was phenomenal.
- It was perfect
- I have participated in 3 internships programs and this has been the best one, even though it was not in the nicest locale nor close to a beach like my pervious ones. the people associated with this program are very aware of what students need and went above and beyond to make this a great summer experience.

3 Conclusion

Overall, the program was very successful in its goals of interesting students in a career in science and engineering, in equipping them for such a career, and providing with strong research experience and skills. Furthermore, the evaluation scores for this year were equal to or greater across the board compared to the third year of the program (2106). In addition, while the program maintained high levels of exposure to research and mentoring, it also showed significant improvements in the program's on-campus administration and students' experience.

We look forward to building on this evaluation and even improving MacREU even more in 2018.