

Materials Connection REU Site (MacREU R'Side) Evaluation, 2022*

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Abstract

This is the evaluation for the ninth 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 Ph.D. The evaluation of the program showed that the students gained considerable research skills and professional development over the summer in every respect we measured. This evaluation shows that the 2022 program equaled the already very strong results of the previous years. In particular, the program maintained high levels of exposure to research and mentoring, which translated into the acquisition of research skills, professional development, and aspirations of a career in science and engineering on the side of the participants.

1 Introduction

“Materials Connection REU” (MacREU R’Side) was a 10 week REU site, held in the summer of 2021, in which 13 undergraduate students, mostly from Southern California colleges, had the opportunity to conduct research in science and engineering labs on the UCR campus. The students largely came from demographic groups that are under-represented in STEM fields, including 38 percent Hispanic, 46 percent non-Hispanic URM students, and 62 percent female or not gender identified.

The PI carefully screened students with ZOOM interviews and selected among applicants those who showed promise in science but were at risk of not pursuing a career in science. Among the 13 students, X hailed from two year colleges, X came from non-research intensive four-year colleges and the remaining from research-intensive universities. In particular, besides UC Riverside, the students had the following home institutions: California Baptist University, Riverside City College, Santa Clara University. 8 out of the 13 participants originated from institutions without significant research infrastructure, 5 of them from a community college. Five UCR students, in addition to participating as full MacREU fellows, also helped host non-UCR students in the various research labs.

All of the students’ research projects were related to the growth, characterization, simulation 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 program alumni that describes their research and experience in the program.

This evaluation draws on 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. In addition, we spend the last day of the program soliciting qualitative responses from the participating students in an in-person debriefing session.

Overall, the eighth cohort of the program (MacREU skipped 2020) well met its academic goals and broader impacts of exposing these students to research, building their academic research skills, and gaining their interest in pursuing science and engineering as a career at the Ph.D. level. In every measure in this evaluation, the 2022 program equaled the extremely strong results we observed from the previous 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 13 NSF-funded students; each 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.

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.	8%	8%	8%	23%	54%	0%	4.1	13
1.2 Figuring out the next step in a research project.	0%	8%	23%	15%	54%	0%	4.2	13
1.3 Problem-solving in general.	8%	0%	8%	23%	62%	0%	4.3	13
1.4 Formulating a research question that could be answered with data.	8%	15%	8%	23%	46%	0%	3.8	13
1.5 Identifying limitations of research methods and designs.	0%	8%	23%	8%	62%	0%	4.2	13
1.6 Understanding the theory and concepts guiding my research project.	0%	0%	15%	38%	46%	0%	4.3	13
1.7 Understanding the connections among scientific disciplines.	0%	0%	31%	23%	46%	0%	4.2	13
1.8 Understanding the relevance of research to my coursework.	0%	0%	31%	15%	54%	0%	4.2	13

Summary of scale results

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

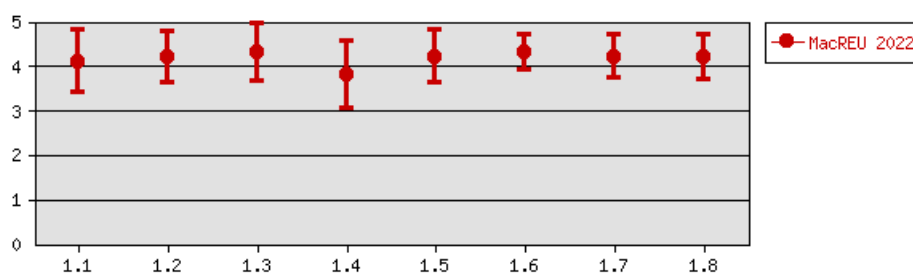


Figure 1: Gains in Thinking and Working Like a Scientist

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 their own gains from the program in learning how to think scientifically and work like a scientist, and to apply scientific knowledge to research. Overall, students report good to great gains in skills such as analyzing data for patterns, formulating a research question

¹See <https://salgsite.net/>, accessed February 8, 2023.

and understanding theory and concepts. While there is a little variability in responses, virtually all students report good or great gains in developing this capacity.

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%	8%	15%	31%	46%	0%	4.2	13
2.2 Comfort in discussing scientific concepts with others.	0%	0%	15%	31%	54%	0%	4.4	13
2.3 Comfort in working collaboratively with others.	0%	0%	8%	38%	54%	0%	4.5	13
2.4 Confidence in my ability to do well in future science courses.	0%	8%	15%	15%	62%	0%	4.3	13
2.5 Ability to work independently.	0%	8%	8%	15%	69%	0%	4.5	13
2.6 Developing patience with the slow pace of research.	0%	0%	15%	15%	69%	0%	4.5	13
2.7 Understanding what everyday research work is like.	0%	0%	8%	15%	77%	0%	4.7	13
2.8 Taking greater care in conducting procedures in the lab or field.	0%	0%	0%	31%	69%	0%	4.7	13

Summary of scale results

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

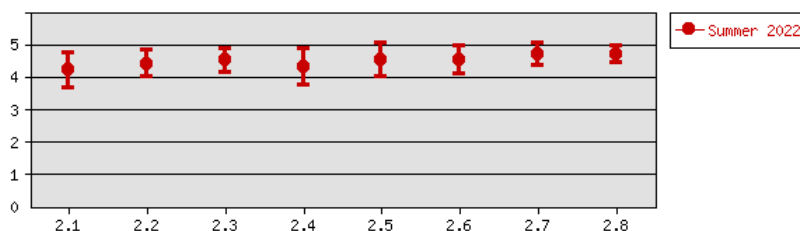


Figure 2: Personal Gains Related to Research Work

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. Each confidence interval essentially equals or exceeds a good level of gain response.

Figure 3 also presents firm evidence that students improved their professional skills such as how to prepare a scientific poster, communicating their research to others, and understanding journal articles. Students tend to report moderate to great gains in these skills across the board. That said, students report only making modest gains for some of the research skills, such as writing scientific papers or keeping a detailed lab notebook, which might reflect that working in labs over the summer does not impart the same amount of writing skills that one would get in coursework. It is possible too that some of the labs use some system other than notebooks to record procedures and outcomes.

Figure 4 continues to support the view that students gained in their self-efficacy for conducting research, where students typically indicated they 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, and interacting with scientists from outside of the school. Many also felt confidence in their own ability to try out new ideas or procedures on their own, although the report this at a slightly lower rate than students in the 2021 cohort.

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%	31%	15%	15%	31%	8%	3.5	12
3.2 Making oral presentations.	0%	0%	15%	31%	54%	0%	4.4	13
3.3 Defending an argument when asked questions.	0%	0%	46%	23%	31%	0%	3.8	13
3.4 Explaining my project to people outside my field.	0%	0%	0%	38%	62%	0%	4.6	13
3.5 Preparing a scientific poster.	0%	0%	0%	23%	77%	0%	4.8	13
3.6 Keeping a detailed lab notebook.	8%	23%	15%	15%	23%	15%	3.3	11
3.7 Conducting observations in the lab or field.	0%	0%	23%	15%	62%	0%	4.4	13
3.8 Using statistics to analyze data.	8%	15%	15%	15%	38%	8%	3.7	12
3.9 Calibrating instruments needed for measurement.	8%	15%	46%	0%	31%	0%	3.3	13
3.10 Working with computers.	8%	8%	8%	23%	46%	8%	4.0	12
3.11 Understanding journal articles.	0%	8%	8%	23%	62%	0%	4.4	13
3.12 Conducting database or internet searches.	0%	8%	23%	23%	46%	0%	4.1	13
3.13 Managing my time.	0%	15%	15%	38%	31%	0%	3.8	13

Summary of scale results

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

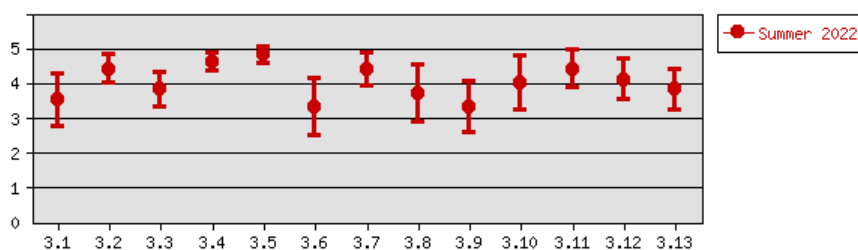


Figure 3: Gains in Academic Skills

Overall, figure 5 shows that students rated the quality of their research experience as excellent, 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 schools. The estimates show a bit more uncertainty compared to the 2021 cohort, but that might simply be due to the small number of participants.

The questionnaire also give students an opportunity to add more thoughts on the quality of their research experience and they wrote as follows. With one exception, the students overall write very positive comments about their experiences in the lab. One student however wished to have more hands-on opportunities in their lab.

- I truly enjoyed my experience in the lab working with my lab mentor. I have learned a great deal from them and my labmates this summer and look forward to continuing my time working in the lab until I graduate this June.
- The best part of my time here was with my graduate student mentor. He positively impacted my career and i learned so much from him.

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%	15%	15%	69%	0%	4.5	13
4.2 Feel like a scientist.	0%	15%	0%	23%	62%	0%	4.3	13
4.3 Think creatively about the project.	8%	8%	8%	31%	46%	0%	4.0	13
4.4 Try out new ideas or procedures on your own.	31%	8%	15%	8%	38%	0%	3.2	13
4.5 Feel responsible for the project.	8%	15%	0%	15%	62%	0%	4.1	13
4.6 Work extra hours because you were excited about the research.	8%	8%	23%	15%	46%	0%	3.8	13
4.7 Interact with scientists from outside your school.	8%	0%	23%	8%	62%	0%	4.2	13
4.8 Feel a part of a scientific community.	0%	8%	0%	15%	77%	0%	4.6	13

Summary of scale results

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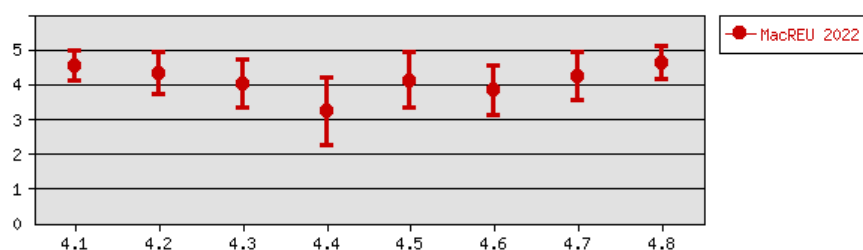


Figure 4: Attitude and Behavioral Changes

- I learned a great deal from my research group and my grad mentor. She and other members of the group helped me understand more about what graduate school entails and took the time to tell me why they particularly chose the graduate path they did. I would not have gained this valuable insight, even into which graduate field to apply in, if not for this experience.
- My graduate mentor was very attentive and responsive. He helped me learn the relevant techniques and always took the time to answer my questions.
- This experience was extremely elucidating on the different avenues that researchers can follow. I feel like now I can confidently navigate a potential career path in academia with an understanding of what I'm getting myself into.
- My mentor was very helpful and very supportive he might have been tough but I believe I have grown as a scientist because of him
- My peer mentor was sweet and helpful but I thought she could have been a little more involved. I wanted to learn more but she never had a set schedule for us. I think that would have been beneficial for the grad mentors to have some sort of outline to make sure the students are in the lab enough.

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%	0%	23%	38%	38%	4.2	13
5.2 My working relationship with research group members.	8%	0%	31%	15%	46%	3.9	13
5.3 The amount of time I spent doing meaningful research.	0%	15%	8%	15%	62%	4.2	13
5.4 The amount of time I spent with my research mentor.	0%	8%	23%	23%	46%	4.1	13
5.5 The advice my research mentor provided about careers or graduate school.	8%	8%	23%	8%	54%	3.9	13
5.6 The research experience overall.	0%	0%	0%	31%	69%	4.7	13
5.7 Please comment on any of these aspects.	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.

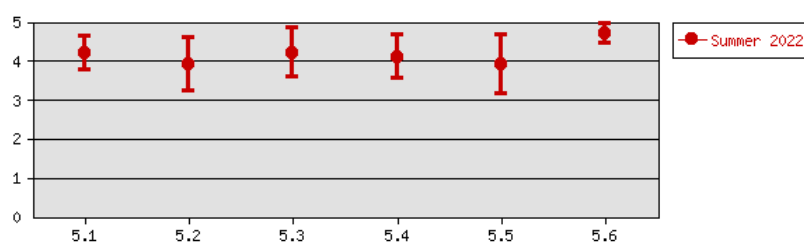


Figure 5: Quality of Research Experience

- My mentor asked about me and my goals and wanted to provide many times useful advice about the industry our project is related to. There are only 2 people working in the lab I'm in and I only saw other research group members twice. I know that my mentor invited me to the lab whenever there was something that I could assist with. They also allowed me to go use machinery and equipment that they were using for our project or others. My mentor was supportive and made the overall research experience more welcoming.
- Working with my mentor was an adjustment in the beginning, he was tough on me and pushed me to be an independent thinker. Though it was initially difficult for me, I feel it made me grow immensely as a scientist.
- My lab had this issue where I was not able to do any work for a few weeks due to supply issues
- I better understand how research is done.
- I enjoyed my research experience. However, there would be large periods of time where I would not be doing anything but just waiting for a reaction to happen. I would prefer more hands-on research work. I only did synthesis for my research and nothing else. I did not use any "cool" instruments or analyzed data. I loved my graduate mentor but would have preferred a different aspect of research that had more involvement because at some point, my "research" was just synthesizing

nanowires, and nothing else...all of the synthesis was in a reaction tube, so I never got to use any cool instruments.

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	100%	0%					-- 13
6.2 I presented a talk or poster at a professional conference	31%	69%					-- 13
6.3 I attended a conference	31%	69%					-- 13
6.4 I wrote or co-wrote a paper that was published in an academic journal	0%	100%					-- 13
6.5 I wrote or co-wrote a paper that was published in an undergraduate research journal	0%	100%					-- 13
6.6 I will present a talk or poster to other students and faculty	92%	8%					-- 13
6.7 I will present a talk or poster at a professional conference	92%	8%					-- 13
6.8 I will write or co-write a paper to be published in an academic journal.	46%	54%					-- 13
6.9 I will write or co-write a paper to be published in an undergraduate research journal.	23%	77%					-- 13
6.10 I won an award or scholarship based on my research	0%	100%					-- 13

Figure 6: Research Activities

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 each of them (100 percent) indicated that they presented a poster. 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. Virtually all of them however plan to present a poster or talk to other students and faculty and at professional conferences. These rates for engaging in research communication are all slightly higher compared to the 2021 cohort.

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. Across all of the measures, students report agreeing that participating in the program enhanced their preparation for a career in science, especially items 7.1 "Doing research confirmed my interest in my field of study," 7.2 "Doing research clarified for me which field of study I want to pursue," and 7.4 "My research experience has prepared me for graduate school."

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

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.	0%	8%	38%	54%	3.5	13
7.2 Doing research clarified for me which field of study I want to pursue.	0%	23%	23%	54%	3.3	13
7.3 My research experience has prepared me for advanced coursework or thesis work	8%	8%	54%	31%	3.1	13
7.4 My research experience has prepared me for graduate school.	0%	8%	54%	38%	3.3	13
7.5 My research experience has prepared me for a job.	8%	8%	38%	46%	3.2	13

Summary of scale results

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

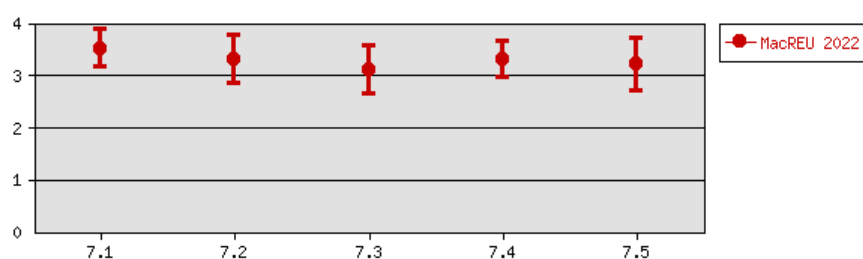


Figure 7: Effects of Research Experience on Personal Advancement

track, since if students entered program on a science career track they also would have indicated no gains. These rates, however, are a bit lower compared to the 2021 cohort.

The questionnaire also asked students 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.” Students wrote,

- Before the research, my goal was just a bachelors in chemistry. Now, I am very very interested in attending graduate school.
- My intended degree before beginning the program was in Civil Engineering. However, after the work in the lab and experience with the other graduates of various fields, not to mention the talks from and conversations with deans who came to present to us, I am now much more considering a degree within Mechanical Engineering. I was always intending on enrolling in a graduate degree, however now I am much more decided on enrolling in a graduate program soon after gaining a Bachelors at whatever school I transfer too. I am also much more decided on a PhD program as opposed to a Masters, due to the knowledge I have gained in the MacREU program.
- I am hoping to attend medical school (M.D.). I was very set on this goal before the research experience, and this research experience has reaffirmed to me that medicine is the correct path.

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?	15%	0%	0%	46%	38%	0%	3.9	13
8.2 enroll in a masters program in science, mathematics or engineering?	23%	8%	23%	8%	23%	15%	3.0	11
8.3 enroll in a combined M.D/Ph.D program	23%	8%	31%	15%	15%	8%	2.9	12
8.4 enroll in medical or dental school?	46%	8%	0%	0%	8%	38%	1.6	8
8.5 enroll in a program to earn a different professional degree (i.e. law, veterinary medicine, etc.)	62%	0%	0%	0%	8%	31%	1.4	9
8.6 pursue certification as a teacher?	46%	8%	8%	8%	8%	23%	2.0	10
8.7 work in a science lab?	0%	8%	15%	8%	69%	0%	4.4	13
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.

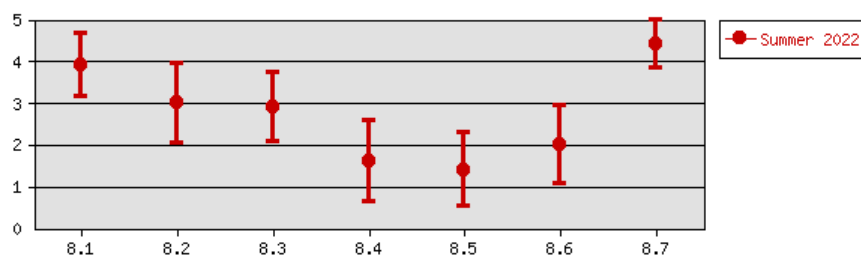


Figure 8: Effect of Experience on Entering the Pipeline

- My intended degree is a double major in physics and math. Before this research, I only intended to get my bachelor's degree and then enter industry, with vague thoughts on graduate school possibly. Now, after doing research, I am extremely likely to enroll in a graduate program.
- It solidified my decision to apply to grad school
- I am actively pursuing looking for a PhD program I like and that would fit for me. I am still not sure if it is something I should do, I believe it to be apart of my career path but I am also trying to consider if just starting work from graduation would be a better option. A lot of it comes down to money and which will make me more money in the future.
- I know now that I will enter a masters program after I go into industry for a time. I think that more advanced graduate research will be an important experience for me.
- I intend to graduate in December 2022 with my bachelors in Chemistry. Prior to

doing research I intended to go into industry, however after this research experience I am strongly considering applying to Ph.D programs.

- Bioengineering. I knew I wanted to do Ph.D school before I started this program and now it has solidified my interest
- Bachelor's in Aerospace Engineering. Very likely to enroll in a graduate program at some point in the future.
- I am pursuing a bachelor of science in chemistry. Before doing research at MacREU, I had intentions to pursue graduate school for a master's degree but was unsure. Now that I finished the program, I am very likely to enroll in graduate school to pursue either a master's degree or a Ph.D. Having the research experience, sparked me to continue my education.

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

- My research experience this summer confirmed my intentions of applying to a phd program this coming December.
- I had a great PI who loves a good work-life balance. He made me feel as if graduate school is achievable for me. He positively influenced me to think seriously about graduate school despite having a family.
- I was already thinking of both, however this research experience helped me to really know, more than before, what it is I want to do in my future. I gained valuable insight from the speakers about life in industry, which I hope to go with my degree, but also solidify my graduate enrollment plan, which I am very focused on pursuing in the immediate future.
- This research experience reaffirmed to me that I want to attend medical school. I thoroughly enjoy research, and the program confirmed that I want it to be a contributing part of my medical career. I hope to continue doing research throughout my career, though I do not want to earn a Ph.D.
- This research experience heavily influenced my future career and graduate school plans. It made me realize I want to go to graduate school and do research as a career.
- My research experience helped me imagine what it would be like to be a graduate student
- The research I did this summer did not particularly make me want to go into lab all the time. I often did not see a purpose in my research besides that it was practice doing things in the lab, which I am still grateful for. Although it was not necessarily something I looked forward to I still thought it is good practice. I did really like

the overall research goal, I just wish I would have been able to do more and learn more transferable lab skills. I didn't really get a chance to use any characterization instruments. Although my research experience was not super fun and exciting, I was still able to see myself getting a project that I am passionate about and pursuing my PhD.

- My research experience informed my future career as a subject I had previously believed I would have interest in was shown to me to be more valuable than I had known. Because the specialized field I want to enter is so broad and detailed I would want the deeper understanding that graduate school can provide.
- My research experience opened my mind to enrolling in a Ph.D program. Working in a lab allowed me to see what day-to-day life would be like in a Ph.D program, and it ended up being a lot less intimidating than I expected.
- This experience confirmed my interest in going to graduate school and pursuing research
- It helped me understand what field I wanted to go to.
- I better know how to plan for, what to look for, and what to expect in a graduate program.
- I was unsure of what field to pursue later in graduate school before the MacREU program. However, I personally do not know if doing research is for me to the level of a Ph.D. degree. I will pursue a Master's degree in nanotechnology, chemical engineering, or pure chemistry, but my lack of patience will not prevail in a Ph.D. program. However, being surrounded by Ph.D. candidates, I am open to the possibility of pursuing a Ph.D degree since I have been enlightened by my mentors. At the same time, I feel as if I need to help my community with more hands-on work, such as dentistry.

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 gained new friends and colleagues. This is important in the academic world as we tend to become enveloped in our studies and only focus on that.
- I created a great network, amongst my peer participants as well as in my lab. I was able to form connections socially and professionally, all with like minded people.
- Yes, too many to even list. However, I would say the greatest gain was learning to think of how to accomplish a research project and how to fix problems in the lab without a step by step guide or lab manual. I feel that, in any STEM or science field, that experience is invaluable.
- I learned how to work with others and convey my research to others. I did not previously know how to convey my research to other academics from different fields. I am now much more confident in presenting my research to a wide range of audiences.

- I built job skills that are useful in a lab setting, and learned the structure and logistics of how a research lab operates. yes i made a lot of new friends and colleagues :)
- The other gains I made were humility and tact because I learned how to accept a failed experiment. I also gained mental well being from being in new experiences.
- Growth in the ability to work with others and networking skills.
- I was able to better understand how to approach reading scientific articles because before this program, I would have trouble understanding the topics proposed in research articles. My graduate mentor and the MacREU program helped me learn tips/tricks to better understand the material. I am confident in my scientific literature abilities now.

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.	15%	0%	8%	38%	38%	--	13
11.2 Support and guidance from program staff.	0%	15%	15%	15%	54%	--	13
11.3 Support and guidance from my research mentor.	0%	0%	15%	15%	69%	--	13
11.4 Support and guidance from other research group members.	8%	0%	0%	23%	69%	--	13
11.5 Research group meetings.	15%	0%	8%	31%	46%	--	13
11.6 Financial support.	0%	0%	8%	31%	62%	--	13
11.7 Group social activities.	0%	0%	8%	23%	69%	--	13

Figure 9: Satisfaction with the Program

Figure 9 indicates that students overall were satisfied with the organization and structure of the program itself. The program included training and involvement with lab personnel; we had a dedicated staff person (Rebecca Ryan) and graduate research assistant who were able to provide constant attention to the group training and activities, and more planned social activities. Overall we see high levels of satisfaction, especially on items 11.2 “Support and guidance from program staff,” 11.3 “Support and guidance from my research mentor,” 11.4 “Support and guidance from other research group members,” and 11.7 “Group social activities.”

Figure 10 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 such as a workshop on science writing and presentation, safety training, and ethics. This might continue to be an area for future improvement, although there is only so much training students can do over the course of a 10 week program.

Figure 11 indicates that students learn about research opportunities such as MacREU from a variety of sources, including item 4.1, “I know this institution offered research opportunities for undergraduates before coming here,” item 14.2 “In class,” 14.4 “An announcement,” and, to a lesser extent, 14.5 “A presentation given by professors or students

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.	31%	8%	15%	23%	23%	-- 13
12.2 Training in library/internet/database search methods.	62%	0%	8%	15%	15%	-- 13
12.3 Safety training	0%	8%	15%	31%	46%	-- 13
12.4 Ethics seminar(s)	46%	0%	15%	15%	23%	-- 13
12.5 Training in human or animal subjects regulations.	77%	8%	0%	8%	8%	-- 13

Figure 10: Gains from Professional Training

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	46%	54%					-- 13
14.2 in class	23%	77%					-- 13
14.3 an academic advisor	23%	77%					-- 13
14.4 an announcement (flyer, poster, email, website, etc.)	31%	69%					-- 13
14.5 a presentation given by professors or students about their research	8%	92%					-- 13
14.6 Other (please specify):	Enter codes for text answers						-- 7

Figure 11: Ways to Learn about Research Opportunities on Campus

about their research.” 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:

- My stem center on campus sent a notification on Canvas informing us about this opportunity which then my counselor recommended to me.
- I learned about this prgram from a past participant and a very close friend, who is very passionate about research and science, and who happened to be the Director of Student Experience for the program. He was such a big help to all of us, guiding us and teaching us, as well as answering all the questions we had (usually the same one many times, which he was graciously patient with).
- My professors
- From my PI
- From my P.I

Figure 12 shows that students report a wide range of motivations for participating in research, with high responses on items 15.1 “Explore my interest in science,” 15.2 “Gain

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	100%	0%					-- 13
15.2 gain hands-on experience in research	100%	0%					-- 13
15.3 clarify which field I wanted to study	85%	15%					-- 13
15.4 clarify whether graduate school would be a good choice for me	92%	8%					-- 13
15.5 clarify whether I wanted to pursue a science research career	100%	0%					-- 13
15.6 have a good intellectual challenge	92%	8%					-- 13
15.7 work more closely with a particular faculty member	46%	54%					-- 13
15.8 participate in a program with strong reputation	62%	38%					-- 13
15.9 get good letters of recommendation	85%	15%					-- 13
15.10 enhance my resume	100%	0%					-- 13
15.11 Other (please specify)	Enter codes for text answers						-- 5

Figure 12: Motivations to do research

hands-on experience in research,” 15.4 “Clarify whether graduate school would be a good choice for me,” 15.5 “Clarify whether I wanted to pursue a science research career” 15.6 “Have a good intellectual challenge,” and 15.10 “Enhance my resume.”

The questionnaire also provided students an open-ended question to report motivations they have to do research.

- I enjoy conducting experiments and writing technical papers.
- To see if i liked it
- I would just reiterate all the positive things I gained from this program. Interestingly, while I didn’t come thinking I would change my engineering focus (15.3) that is what the program helped me to consider.
- Meet other students who are motivated, when I am surrounded by others like that, then I usually push myself a lot harder. I also like meeting faculty and being able to see peoples career paths.

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

- I already new what I wanted, which is to attend grad school for a phd.
- They were okay the chemistry graduate program presentation seemed misleading. It was made to seem like UCR is perfect instead of just being honest. It felt like I was being sold something which should NOT be the case.

- The speaker presentations were extremely informative, in both the information about industry and graduate school. I learned a lot from them.
- The speaker events clarified to me that I do not want to earn a Ph.D.
- I learned a great deal about what is necessary and expected from graduate school applicants, and was able to conceptualize what a plan for applying to graduate school would look like.
- Having guest speakers speak was extremely helpful they would give very helpful advice
- I found the people who attended graduate school to be very helpful. I typically ask a lot of questions and get more familiar with the PhD process and things these people have encountered.
- Only 2-3 sessions from speakers applied to my career enough to impact my thought process. The fact there was a great variety was useful.
- The sessions offered on graduate school programs gave me a lot of insight on what graduate programs expect in an applicant.
- I am not taking the GRE but talking to other Ph.ds and professors helped me understand the concepts.
- There were a few activities that helped me for clarifying what I want to pursue in my career. I would have preferred more events/activities where there could be more discussions about different career paths.

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

- I would have liked to be in the lab more. The timing of the GRE meetings conflicted with when experiments began in my lab. nothing research wise. My PI and grad mentor were amazing and made my 10 weeks incredible and enjoyable.
- Honestly this program was fantastic, I can't think of anything that could have made it better. I only wished I had asked even more questions through the experience.
- My research experience was great! It would be great if the speaker events were later in the evening, since I often had to leave the laboratory early to attend them.
- My mentor was very hands off during my research experience and let me explore a great deal on my own. I think that because this was my first research experience, I struggled more than I would have otherwise, and I would have appreciated a more hands on mentorship experience for my first research experience. That is only my personal experience, however. Future experiences with similar mentorship styles may work better now that I have a better understanding of the way it operates

- It would have been better if we had weekly meetings with our cohort and present our research update
- Having my graduate mentor and I be on the same page. I wish we had a schedule or something to keep her a little more accountable. She was willing to help me out but she would often give me work to do alone which was just the same thing over and over. I still found it useful but I wish we had a schedule where twice a week we could meet and she would teach me something new. I feel like our schedules were maybe a little off and our communication was ok. She was caring but I thought she could have pushed me a little more. It is hard to describe bc she was very sweet.
- It could have been better if my mentor and PI were more involved with the staff of MacREU. I also could have been aided if we were provided more resources to use to inform our mentors of the program, like pamphlets or emails.
- More preparation for presentations.
- It would have been better if my project went more smoothly...
- If the program coordinators were more respectful of my time when planning events and keeping it timely. Also I wish that my P.I was more engaged in assigning work.
- Better parking; more frequent payment; gre experience that analyzed how to approach questions, tips/tricks, etc., not just thrown into answering questions from the start; more bonding events; more coffee available; GRE tutor; more talk sessions to have career advice

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

- The program could improve with someone more qualified to conduct GRE trainings as well as run the program efficiently; someone more mature and experienced, preferably with class settings and etiquette.
- More money. because i felt no one was paid enough for all the work they did. also payments on TIME. not just randomly. More serious discipline for students not behaving right. there were several who should have been kicked out and for some crazy reason, they stayed on. ridiculous.
- This program was fantastic, every event, training, speaker, and presentation was very well put together and executed smoothly.
- I would like to hear more about people with Ph.D.s in other careers. For example, it would be interesting to see how people with Ph.D.s in science have jobs outside of academia.
- This experience was incredible, and with no frame of reference to what other research looks like, I have no comments.

- More group social activities that let us discuss our research
- Maybe have the graduate students have a meeting with their PI to show them what we will be working on in research and have an outline or some kind of plan.
- The program was almost perfect in terms of structure of time being used. There was sometimes a few problems with the other aspects. Communication needed improving at first, but it is likely that is fixed already.
- More workshops and guidance on how to write papers, make posters and presentations and other non-laboratory scientific skills we need.
- I like everything the way it is
- I would appreciate more engaging topics in the place of some of the GRE. Like more research related activities or professional training or grad school application prep time.

3 Year over Year

Before closing, we provide a comparison of the performance of our REU site year-over-year using select scores from the evaluation. Given the relatively small sample number/number of participants each year, each of whom bring their very own expectations and aspirations to the program, the weight of such an analysis may be somewhat limited. We encourage that for a better idea about the program, the individual reports and the student responses contained therein are consulted. Nevertheless, this analysis shows that after the first two years, which were our learning curve, we provide the MacREU fellows a research program that they consistently appreciate.

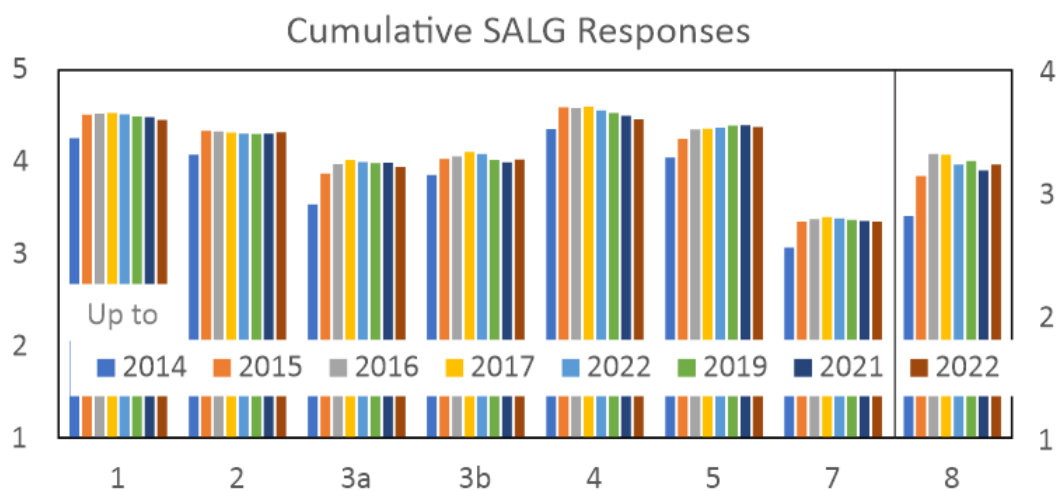


Figure 13: Year-over-Year variation of Metrics

4 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 the baseline year of the program (2106) and equalled the high scores from the program's previous year (2021). 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 2023.