

REU Site: Undergraduate Research in Smart Environments: Year 6 Evaluation Report
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Since the Undergraduate Research in Smart Environments program began in 2015, Pre and post program surveys were employed to assess the impact the program has had on students’ (1) research skills and (2) attitudes toward graduate school. The survey was also used to assess students’ (3) satisfaction with mentors and (4) overall satisfaction with the REU experience. In addition, in order to gauge the REU mentors’ abilities to (5) provide authentic research experiences to the students, (6) improve students’ research skills, and (7) advise undergraduate students, pre and post program mentoring survey were administered. Finally, follow-up communications with the REU students and faculty mentors, provided further data on the students’ eventual (8) publication of research, and (9) enrollment in graduate school.

In 2020, 7 students participated in the WSU REU program. 7 students completed the pre-REU survey and 6 completed the post-REU survey. 2020 was an unusual year in that the entire program was conducted in an online environment because of the COVID-19 pandemic. The project team intends to follow up with students in 2021 to see if the 2020 cohort: (a) finished their BS degrees, (b) had any publications/ presentations related to their REU experiences, and (c) pursued graduate degrees.

SUMMARY OF STUDENT RESULTS 2015-2020

TABLE 1. Summary of student results 2015-2020.

Indicator		Results 2015-2020
1.	Retention in undergraduate science & engineering programs	<ul style="list-style-type: none"> • 2020: This is the final year of the program, so data won’t be collected in 2021. • 2019: (N=8 respondents out of 10): 2 of the 8 completed STEM BS degrees in May 2020. • 2018: (N=7 respondents out of 10): by 2019, 3 completed their BS programs; 4 still in their BS programs. 2017: (N=6 respondents out of 10): by 2018, 5 were still in their BS programs. • 2016: (N = 10 respondents out of 11): by 2017, 9 completed their BS degrees; 1 participated in student mentoring. • 2015 (N= 6 respondents out of 10): by 2016, 5 completed their BS degrees, with 1 ongoing.
2.	Publications and presentations	<ul style="list-style-type: none"> • 2020: This is the final year of the program, so data won’t be collected in 2021.

	involving REU participants	<ul style="list-style-type: none"> • 2019: Two publications: (1 journal paper, and 1 conference paper), and one 1st place prize for their senior design team project, which was based on the project this REU student worked on. • 2018: 1 journal paper published over the 2018-2019 academic year. • 2017: 1 conference proceedings paper during the REU. 4 conference papers were published over the 2017-2018 academic year. • 2016: (N = 10 respondents out of 11): by 2017, 3 conference proceedings papers, 1 poster, and 1 senior design project • 2015 (N= 6 respondents out of 10): by 2016, 1 conference proceedings paper
3.	Percentage of students that go on to graduate school	<ul style="list-style-type: none"> • 2020: This is the final year of the program, so data won't be collected in 2021. • 2019: 5 of the 8 said when asked in 2020 say they plan to pursue graduate school after their BS. 3 of the 8 say they plan to attend graduate school later; the 2 who graduated were both in this "later" group. • 2018 (Pre-REU: N = 9; Post-REU: N=3): <u>Pre-REU</u>: 1 student indicated Strongly Agree; 3 Somewhat Agree; 4 Neutral; 1 Somewhat Disagree; <u>Post-REU</u>: 1 student indicated Strongly Agree; 2 Strongly Disagree 1 Disagree. Post –REU: 1 Somewhat Agree; 2 Strongly Disagree. • 2017 (N= 6 out of 10 respondents): one student entered graduate school fall 2018; all other respondents intended to pursue a graduate degree. (Pre-REU: N= 9; Post-REU=7): Pre-REU: 4 Strongly Agree they plan to go to graduate school; 3 Somewhat Agree; 2 Neutral. Post-REU: 4 students indicated Strongly Agree they plan to apply to graduate school; 1 Somewhat Agree; 1 Neutral; 1 Somewhat Disagree. • 2016 (N= 9 respondents out of 11): 5 students entered graduate school; 2 plan to enter graduate school; 2 took jobs in industry. • 2015 (N= 6 respondents out of 10): 3 entered graduate school, 2 planned to enter graduate school; 1 didn't plan to go to graduate school.
4.	Contentment of students	<ul style="list-style-type: none"> • 2020: (N=7): the 2020 cohort indicated overall contentment, save for one student who was dissatisfied, primarily it seemed by the mentor's performance. • 2019: (N=8): the 2019 cohort was the most content/most satisfied with the experience, what they learned, and their mentors of all cohorts since 2015.

		<ul style="list-style-type: none"> • 2018: (N = 3 respondents out of 11) Of the three respondents, 1 was highly content/satisfied, 1 satisfied and 1 highly dissatisfied. • 2017: The 2017 cohort was much less content/less satisfied with the mentor-mentee relationship and the overall research experience than previous cohorts. • 2015 & 2016: The majority of 2015 & 2016 students were generally content/satisfied with all aspects of the REU program.
5.	Percentage of REU participants from under-represented groups	<ul style="list-style-type: none"> • 2020 cohort included: 57% (N=4) women and 43% (N=3) men; 2 Hispanic/Latino, 5 Caucasian • 2019 cohort included: 20% (N=2) women and 80% (N=8) men; 7 Caucasian, 2 Asian, 1 African American • 2018 cohort included: 44% (N=4) women and 56% (N=7) men; 7 Caucasian, 4 Asian • 2017 cohort included: 40% (N=4) women and 60% (N=6) men; 1 Hispanic/Latino, 2 Other, 2 Asian, 5 Caucasian • 2016 cohort included: 44% (N=4) women and 56% (N=7) men; 1 Hispanic/Latino, 1 African American, 2 Other, 7 Caucasian • 2015 cohort included: 40% (N=4) women and 60% (N=6) men; 2 Hispanic/Latino, 2 African American, 1 Other, 5 Caucasian
6.	Improved student understanding of the research process	<ul style="list-style-type: none"> • From 2015-2020, the majority of students indicated that after completion of the REU program, they had a better understanding of the research process and its application.

2019 DETAILED STUDENT RESPONSES

Student perception of attending graduate school.

TABLE 2. 2020 participants (Pre-REU: N=7; Post-REU: N=6). *Please rate your level of agreement to the following statements, where 5 is Strongly Agree and 1 is Strongly Disagree.*

1.	I plan to apply to graduate school.	<u>Pre-REU:</u> 2 Strongly Agree; 3 Agree; 2 Neutral <u>Post-REU:</u> 4 Strongly Agree; 1 Agree; 1 Disagree
2.	Which discipline do you plan to pursue?	<u>Pre-REU:</u> 1 Engineering; 1 Math; 5 Computing (1 detailed Computer Science/Data Science) <u>Post-REU:</u> 5 Computing; 1 Computer Science

Improved Understanding of the Research Process

TABLE 3. 2020 participants (Pre-REU: N=7; Post-REU: N=6) *Please rate your degree of confidence with the following statements, where 5 is Very Confident and 1 is Very Unconfident.*

I can:		
1.	Locate primary research literature	<p><u>Pre-REU:</u> 3 students indicated Somewhat Confident; 3 Neutral; 1 Somewhat Unconfident</p> <p><u>Post-REU:</u> 4 students indicated Very Confident; 2 Somewhat Confident</p>
3.	Formulate a research hypothesis	<p><u>Pre-REU:</u> 2 students indicated Somewhat Confident; 2 Neutral; 3 Somewhat Unconfident</p> <p><u>Post-REU:</u> 2 students indicated Very Confident; 4 Somewhat Confident</p>
4.	Design an experimental test of a solution to a problem	<p><u>Pre-REU:</u> 2 students indicated Somewhat Confident; 2 Neutral; 3 Somewhat Unconfident</p> <p><u>Post-REU:</u> 4 students indicated Very Confident; 2 Somewhat Confident</p>
5.	Collect data	<p><u>Pre-REU:</u> 1 student indicated Very Confident; 4 Somewhat Confident; 1 Neutral; 1 Somewhat Unconfident</p> <p><u>Post-REU:</u> 3 students indicated Very Confident; 2 Somewhat Confident; 1 Neutral</p>
6.	Statistically analyze data	<p><u>Pre-REU:</u> 1 student indicated Very Confident; 3 Somewhat Confident; 1 Neutral; 2 Somewhat Unconfident</p> <p><u>Post-REU:</u> 3 students indicated Very Confident; 2 Somewhat Confident; 1 Very Unconfident</p>
7.	Interpret data analyses	<p><u>Pre-REU:</u> 3 students indicated Somewhat Confident; 2 Neutral; 2 Somewhat Unconfident</p> <p><u>Post-REU:</u> 2 students indicated Very Confident; 3 Somewhat Confident; 1 Somewhat Unconfident</p>
9.	Orally communicate the results of research projects	<p><u>Pre-REU:</u> 1 student indicated Very Confident; 4 Somewhat Confident; 1 Neutral; 1 Somewhat Confident</p> <p><u>Post-REU:</u> 3 students indicated Very Confident; 2 Somewhat Confident; 1 Neutral</p>
10.	Write a research paper for publication	<p><u>Pre-REU:</u> 3 students indicated Neutral; 3 Somewhat Confident; 1 Somewhat Unconfident</p> <p><u>Post-REU:</u> 1 student indicated Very Confident; 3 Somewhat Confident; 1 Neutral; 1 Somewhat Unconfident</p>

11.	Work with others to investigate a research problem	Pre-REU: 4 students indicated Somewhat Confident; 2 Neutral 1 Somewhat Unconfident Post-REU: 2 students indicated Very Confident; 3 Somewhat Confident; 1 Neutral
12.	Discuss research with graduate students	Pre-REU: 4 students indicated Somewhat Confident; 2 Neutral 1 Somewhat Unconfident Post-REU: 2 students indicated Very Confident; 3 Somewhat Confident; 1 Neutral
13.	Discuss research with professors	Pre-REU: 4 students indicated Somewhat Confident; 2 Neutral 1 Somewhat Unconfident Post-REU: 2 students indicated Very Confident; 4 Somewhat Confident

Mentor-mentee relationship

TABLE 4. 2020 (N=6). Please indicate the extent to which you agree with each statement below about your mentor. Scale: Strongly Agree, Agree, Neutral, Somewhat Disagree, Strongly Disagree

My mentor:		
1.	was accessible	4 Strongly Agree; 2 Agree
2.	demonstrated professional integrity	5 Strongly Agree; 1 Agree
3.	demonstrated content expertise in my area of need	4 Strongly Agree; 1 Agree; 1 Neutral
4.	was approachable	4 Strongly Agree; 2 Agree
5.	was supportive and encouraging	4 Strongly Agree; 2 Agree
6.	provided constructive and useful critiques of my work	4 Strongly Agree; 1 Agree; 1 Strongly Disagree
7.	was helpful in providing direction and guidance on research project issues	5 Strongly Agree; 2 Agree; 1 Somewhat Disagree
8.	answered my questions satisfactorily (e.g. timely, clear, comprehensive)	3 Strongly Agree; 2 Agree; 1 Somewhat Disagree
9.	acknowledged my contributions appropriately	3 Strongly Agree; 2 Agree; 1 Neutral

10.	suggested appropriate resources	4 Strongly Agree; 1 Agree; 1 Strongly Disagree
11.	challenged me to extend my abilities	4 Strongly Agree; 1 Agree; 1 Somewhat Disagree

Student contentment/satisfaction with the program

TABLE 5. 2020 (N= 6). *How satisfied were you with:* Scale: Highly Satisfied, Somewhat Satisfied, Neutral, Somewhat Dissatisfied, Highly Dissatisfied

1.	Your faculty advisor	5 Highly Satisfied; 1 Somewhat Dissatisfied
2.	Your housing arrangements	Not Asked in 2020 given the 100% online environment
3.	The program in general	5 Highly Satisfied; 1 Somewhat Satisfied
4.	Your research experience	5 Highly Satisfied; 1 Highly Dissatisfied
5.	Your interaction with project staff	3 Highly Satisfied; 2 Somewhat Satisfied; 1 Neutral
6.	Your interaction with other students	1 Highly Satisfied; 4 Somewhat Satisfied; 1 Highly Dissatisfied

Detailed Student Responses

- I really missed not interacting with students, and I wish there were more opportunities to do so. But I'm not sure how it would have been possible, given the remote experience.
- I had a great experience! I really appreciate the work that went into making this happen virtually for us! While of course I would have rather attended in person, the online experience was still really great! I learned a lot and my mentor was great in guiding me on my project. This experience has been very impactful for me and I am very glad I did it.
- It was an unforgettable and worthwhile experience.
- It was interesting to be able to interact with other students even when it was virtually.

2020 MENTOR RESULTS

The project's four mentor objectives are:

1. Provision of an authentic research experience to students.
2. Encouragement of students to obtain an advanced degree in engineering.
3. Development of students' applied research skills.
4. Becoming more skilled as a faculty mentor (so that students can achieve project goals).

The method chosen to measure the indicators was a brief survey focusing on mentor expectations and the extent to which they were met. 7 mentors responded to the Pre-REU survey and 6 to the Post-REU survey. One student ended up not being able to participate, so the 7th mentor pulled out of the program, thus the Post-REU number.

PRE-REU SURVEY MENTOR RESULTS

The Pre-REU survey questions focused on capturing mentor motivation for participating in the program and expectations of themselves and their students.

TABLE 6. 2020 Summary of faculty mentor (N = 7) pre-REU survey response results by indicator. *Rate the degree to which the following impacted your decision to participate in this summer's REU program.* Scale: Not At All; A Little; A Fair Amount; A Lot.

Indicator		Survey Statement and Responses 2020
1.	Provision of an authentic research experience to students.	<i>I think it's important to give undergraduate students authentic research opportunities.</i> A Fair Amount = 2; A Lot = 5
2.	Encouragement of students to obtain an advanced degree in engineering.	<i>I think the experience will encourage undergraduate students to pursue an advanced degree in engineering.</i> A Fair Amount = 1; A Lot = 6
3.	Development of students' applied research skills.	<i>I think the experience will help undergraduate students develop their applied research skills.</i> A Fair Amount = 2; A Lot = 5
4.	Becoming more skilled as a faculty mentor	<i>I would like to become more skilled at mentoring undergraduate students in the research process.</i> Not at All = 1; A Little = 1; A Fair Amount = 4; A Lot = 1

DETAILED MENTOR PRE-REU SURVEY RESPONSES

What do you expect from the REU student in terms of participation in your research program? (N=7)

- Contribute in some limited way to active research program by trying new ideas or run experiments on more established ideas
- Independent problem solver and a quick learner.

- I expect the students to be involved in all aspects of the research project. This is how they actually learn what research is and how they get passionate.
- The student will know how to conduct literature search and how to formulate research questions as well as how to perform research following a principled methodology.
- Learn, make progress towards deliverable and help me and my research group to be a better mentor.
- 1. Learn about research life cycle. 2. Ability to think about a research problem. 3. Read relevant literature. 4. Take the high-level idea and run with it / own it. 5. Analyzing experimental results and communicating the findings. 6. Good team player to work with other project members including senior PhD students. 7. Meet the research goals for paper deadlines.

What do you expect in terms of research productivity of the REU student? (N =7)

- Perhaps a conference/workshop paper in a follow up work after the summer research period is completed
- Short conference paper (either individual or with senior students)
- I expect students to take initiative and follow the deliverable deadlines as close as possible. Of course, this is research so unexpected things happen but delays should be minimized.
- Obtain solid preliminary results toward publishable work later
- Co-author paper with my research group.
- Take the high-level idea and run with it / own it. Meet the research goals of the project and fulfill their role to meet paper deadlines.
- Weekly progress reports; final research presentation; contribute to research paper.

How do you think you will benefit from serving as an REU mentor? (N =5)

- Help make progress in my lab's research program; promote WSU; learn about my mentee and their background.
- Create future graduate students for the lab and the university / explore unsolved research topics not pursued by senior students
- Hoping to convince the student to join our group as a grad student.
- Improve my skills in mentoring especially across disciplines.
- Some progress on ongoing research progress; satisfaction of exciting a student about research.

How do you think your REU student will benefit from your mentorship? (N =6)

- Improve their applied research skill; be exposed to some of the literature and current research in the topic they will work on; learn to collaborate; develop interest in graduate school.

- ability to work in a research environment and understanding the expectations that comes with it; critical reasoning; benefit for post-graduate studies.
- Explore new research directions; get to know what they are passionate about; learn to be methodological.
- Get rich research experience on a very practical problem and be a team worker.
- Gain strong research experience. Strong reference letters and mentoring to get admissions to top notch graduate programs. Oral and technical communication skills. Professional career development opportunities.
- Better understanding of the challenges of smart environments and of the research process.

POST-REU SURVEY MENTOR RESULTS

Table 7. 2020. Summary of faculty mentor Post-REU survey response results by indicator (N = 6) *Rate the degree to which the following describes your experience in this summer’s REU program.* Scale 1: Not At All; A Little; A Fair Amount; A Lot. Scale 2: Not At All; Somewhat Well; Well; Very Well

Indicator		Survey Statement and Responses 2020
1.	Provision of an authentic research experience to students.	<i>I think the experience gave the undergraduate students authentic research opportunities.</i> A Fair Amount = 1; A Lot = 5
2.	Encouragement of students to obtain an advanced degree in engineering.	<i>I think the experience encouraged the undergraduate students to pursue an advanced degree in engineering.</i> A Fair Amount = 1; A Lot = 5
3.	Development of students’ applied research skills.	<i>I think the experience helped the undergraduate students develop their applied research skills.</i> A Fair Amount = 1; A Lot = 5 <i>When asked: How well did the student meet your expectations in terms of participation in your research program?</i> Somewhat Well = 1; Well = 2; Very Well = 3
4.	Becoming more skilled as a faculty mentor	<i>I became more skilled at mentoring undergraduate students in the research process.</i> A Lot = 1; A Fair Amount = 2; A Little= 2 <i>When asked how much they had benefitted from the mentoring, mentors responded: A Fair Amount = 5; A Lot = 1</i> <i>When asked: How much do you think your REU student benefitted from your mentorship?</i> A Little = 2; A Fair Amount = 3; A Lot = 1

DETAILED MENTOR POST-REU RESPONSES

What suggestions for improvement do you have for the research team as they prepare next year's REU program?

- I really had an excellent experience this year, so I don't have any improvements to suggest.
- I think the research team did an excellent job running the program this year. Just the fact that they chose to run the program remotely while most other REUs in the country were cancelled is admirable. Plus, the team did a great job offering guidance (like helpful presentation tips) to the students and periodically communicating with mentors with information at an ideal frequency -- not too few or too many, just perfect. Keep up the great work!
- This was a different year compared to normal REU programs. However, the virtual interface did provide sufficient interaction between the REU student and the faculty mentor. I don't have any particular suggestions about this.
- This year's program, being virtual, made it hard to keep students engaged full-time in the research. So, for future virtual programs, more frequent interaction and progress reporting is recommended.

EVALUATOR COMMENTS

Overall, the project leadership team has achieved its goals over the sixth years of this project to provide an authentic applied research experience to undergraduate students. For 2020, this is commendable given that the program was run remotely due to the COVID-19 pandemic. The majority of students and mentors agree that the program provides this opportunity, as well as providing motivation for continuing education in graduate programs. Mentors overall seem to enjoy mentoring the students and think that they perform that role adequately, with some students performing above expectations.

Both students and faculty who responded to these surveys in 2020 expressed perception of strong student learning and engagement and were impressed by the student and mentor performance in spite of the program being remotely run this year.