BIO REU Third Year Report

Tim Weston

ATLAS

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Executive Summary

Eight-hundred thirty four BIO-REU students took the URSSA in 2012. Participation has grown substantially since 2010 when 232 students took the survey.

Students in 2012 came primarily (77%) came from public institutions, with a large majority of students (84%) from Research One universities.

Most students in 2012 were either Juniors or Seniors (40% Junior and 22% Senior), and were diverse with 58% White, 16% African American and 26% Hispanic. The majority of students were female (59%).

Twenty-eight percent of students in 2012 never participated in an REU program before, 38% previously participated once and 23% participated twice. Nine percent said they have participated three or more times.

Core indicators are averaged scores on survey items in areas such as "*Application of Knowledge to Research Work"* and *"Attitudes and Behaviors as a Researcher.*" These scores remained remarkably stable over the three years. Significant differences (favoring BIO-REU) were evident for the comparison of BIO-REU groups from each year (2010- 2012) with the larger group of non-BIO-REU students on all indicators. However, no significant differences were seen between years for the BIO-REU group.

Demographic differences on indicators included: 1) Minority students (especially Hispanic students) reported gaining more than Whites on *Personal Gains* and *Skills* indicators, and 2) students who had never participated in REU's said they gained more on *Personal Gains* and *Skills* than students who had attended three or more times.

BIO-REU students reported attending conferences more often than students in other programs (31%), and planned to present and attend conferences at greater rates than students in other REU programs (82%).

Satisfaction ratings of most REU activities and mentors were very high, with averages between 4 and 5 (on a scale of 1 -5). Only a few sites showed lower average satisfaction ratings.

High numbers of students in BIO-REU said they were *much more/extremely more likely* after the REU to do activities such as working in a science lab (51%), enrolling in a Master's program (41%), or enrolling in a Ph.D. program in science, mathematics and engineering (50%). Lower numbers of students responded that they were more likely to enroll in medical school (14%), or enroll in a program for a different professional degree (14%).

Forty-one percent of students reported spending four or more hours with their research mentors. In 2011, 77% reported spending four or more hours per week talking with others in their lab.

Students answering open-ended questions described additional benefits from REU programs such as networking with peers, mentors and graduate students (23%), and learning skills such as lab techniques, data analysis, computer skills, and personal skills such as time management (18%). Other areas mentioned were increased confidence in students' ability to do science (12%), familiarization with practical scientific activities (7%), and clarification of plans for the future (12%).

Twenty-two percent of students 2012 said they changed their minds and will attend graduate school because of the REU.

Thirty-two percent said they confirmed or strengthened an existing decision to attend graduate school during the REU.

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This report presents the results of the *Undergraduate Research Student Self Assessment* (URSSA) for Summer 2012 with comparisons to 2011 and 2010. The survey asked students to report on the benefits of their undergraduate research experience and rate their satisfaction with different areas of their program. Other questions ask students to report the research activities the participated in, how they learned about the program, and if the program changed future educational or vocational plans. Summarized are average scores on survey items, comparisons with matched groups of non-BIO-REU students, comparisons between years for the BIO-REU program, and analysis of demographic differences among students and institutional sites taking the survey.

1.1 About URSSA

The URSSA assessment instrument was developed under NSF grant #CHE-0548488, *Mapping the Extent and Character of the Undergraduate Research Experience at Public Research Universities: An Exploratory Study*, funded by the Divisions of Chemistry and Undergraduate Education, the Biological Sciences Directorate, and the Office of Multidisciplinary Affairs.

The URSSA is a self-report survey instrument intended for use by Undergraduate Research program administrators for program-level evaluation of student outcomes. The assessment is intended for campus organizations like BIO-REU with multiple laboratories where undergraduates work in internships or REU settings.

The survey instrument for BIO-REU contained 132 questions, grouped in 17 blocks of conceptually related items. A core group of items ask students to rate how much they have gained in skills and understanding, and in areas such as "*Application of Knowledge to Research Work"* and *"Attitudes and Behaviors as a Researcher.*" In the online survey, a core group of questions are "locked" and cannot be altered by those administering the survey. The remaining items are optional and can be deleted, moved or edited to customize the survey for a given program. These questions relate to students' satisfaction with the program and its particular components, motivation for joining the program, and demographic information. Salgsite.org, the web platform developed for the SALG classroom instrument, allows for free anonymous online administration of the survey, with users immediately receiving summarized and item-by-item results.

1.2 2012 Administration

In 2012, 834 students at seventy institutions participated in the survey. Three-hundred seventy-two students were from institutions who also participated in the survey in 2011. The number of students taking the survey has grown substantially each year from 231 in 2010 and 581 in 2011. Students in 2012 came primarily (77%) came from public institutions, with a large majority of students (84%) from Research One universities. Most were either Juniors (40%) or Seniors (20%) and were diverse with 58% White, 16% African American and 26% Hispanic. The majority were female (59%). Twenty-eight percent of students in 2012 had never participated in an REU program before, 38% previously participated once and 23% participated twice. Representation by gender, race/ethnicity has remained roughly stable across years.

Table 1 Institutional characteristics for students.

	2010		2011		2012	
	N	%	N	%	N	%
Institute/ private lab	12	5.2%	55	9.5%	46	5%
Associates	--	--	3	.5%	19	2%
Baccalaureate A & S	---	--	16	2.7%	42	5%
Doctoral Granting	29	12.5%	12	2.1%	21	2%
Masters (large)	25	10.8%	23	4.0%	8	1%
Masters (medium)	--	--	--	--	--	--
Specialized*	15	6.5%	7	1.2%	--	--
Research One	151	65.1%	466	80.1%	697	84%

		2010		2011		2012	
Public Private	Public	194	83.6%	420	72.2%	637	77%
	Private	26	11.2%	107	18.4%	137	17%
	Independent Laboratory	12	5.2%	55	9.5%	46	5%

Table 2 Carnegie code and public/private status by institutions 2011 - 2012.

	2010		2011		2012	
	N	%	N	%	N	%
Institute/Private Lab	5	8%	46	5%	6	8%
Baccalaureate A & S	2	3%	19	2%	2	3%
Associates	1	<1%	--	--	--	--
Doctoral Granting	4	7%	42	5%	3	4%
Masters (large)	4	7%	21	3%	3	4%
Research One	42	70%	697	83%	54	80%
Specialized	2	<1%	--	--	--	--
Private	10	16%	13	71%	6	10%
Institute/Lab	5	8%	6	19%	14	20%
Public	51	84%	48	9%	48	70%

Table 3 Demographics for 2010 - 2012.

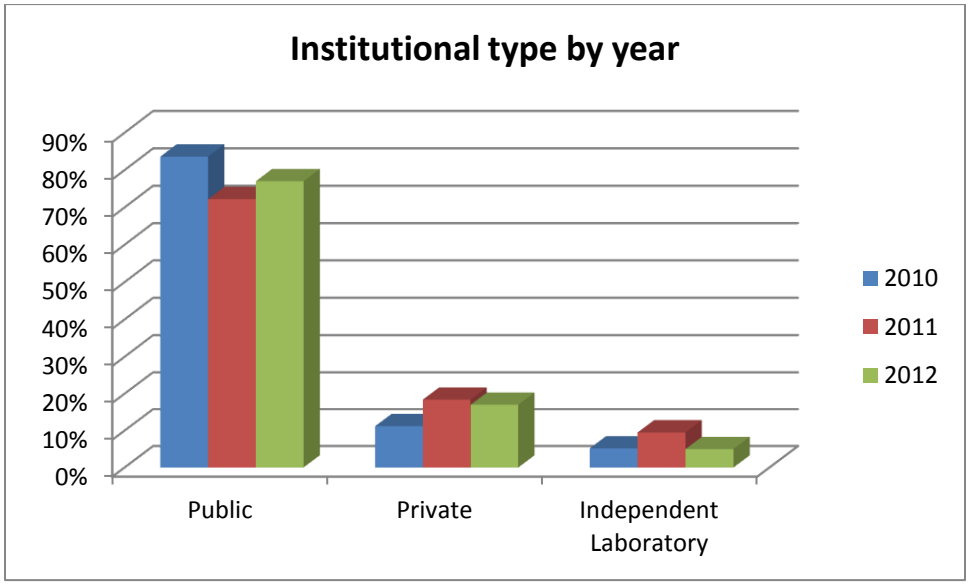
		2010		2011		2012	
		N	%	N	%	N	%
Class Standing	Freshman/Rising Sophomore	19	8.2%	49	8.6%	51	7%
	Sophomore/Rising Junior	54	23.3%	168	29.4%	209	28%
	Junior/Rising Senior	88	37.9%	195	34.2%	293	40%
	Senior	63	27.2%	143	25.0%	157	22%
	Other	8	3.4%	16	2.8%	22	3%
Race/Ethnicity*	Native American	18	7.8%	14	2.6%	16	2%
	Asian American	12	5.2%	46	8.6%	58	7%
	African American	44	19.1%	94	17.5%	133	16%
	Pacific Islander	7	3.0%	9	1.7%	16	2%
	White	108	47.0%	250	46.6%	490	58%
	Hispanic	41	17.8%	124	23.1%	216	26%
Gender	Female	142	61.5%	297	62.1%	490	59%
	Male	89	38.5%	181	37.9%	336	41%

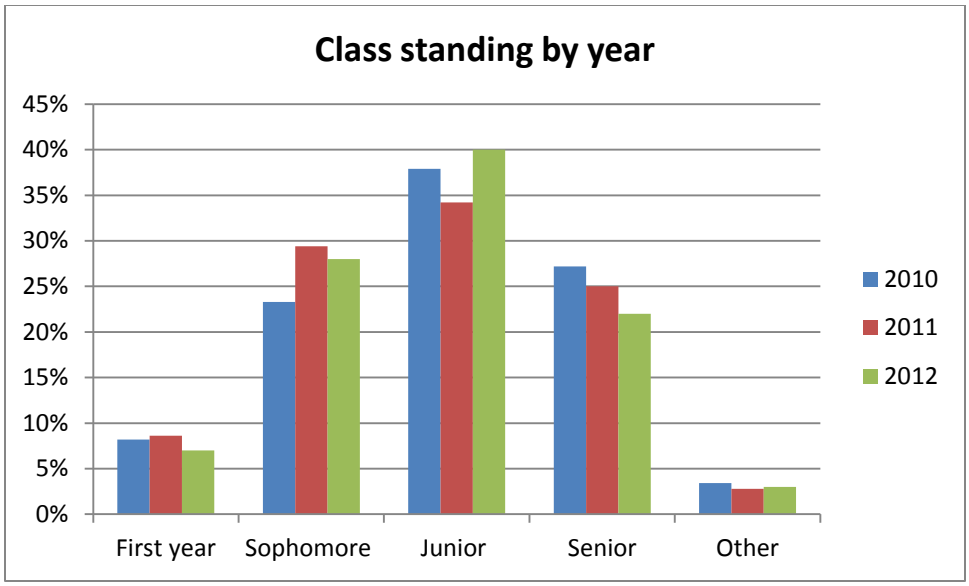
- *Note*: Students identifying as Hispanic and other race were included in classification as Hispanic.
- *Note*: Race/ethnicity does not equal 100 due to Hispanic status for race and ethnicity.

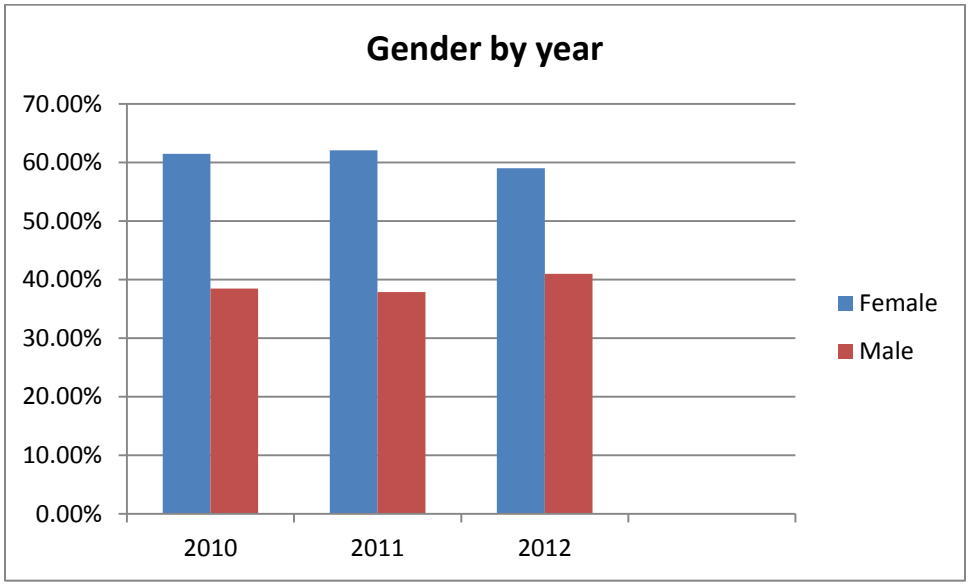
Table 4 Participation in previous research experiences.

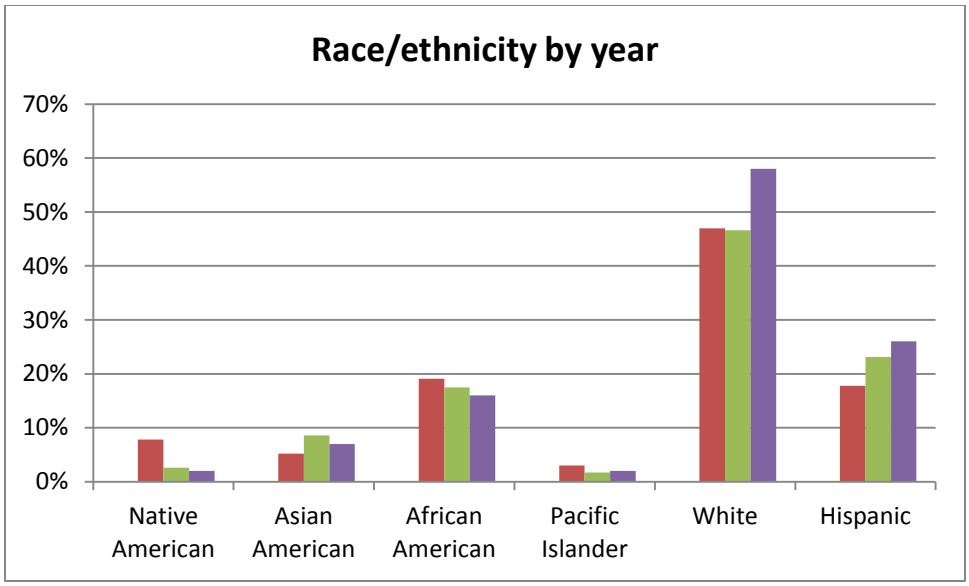
		2010		2011		2012	
		N	%	N	%	N	%
How many times have you participated in summer research?	Never	78	34.4%	176	32%	209	28%
	Once	80	35.2%	211	38%	290	38%
	Twice	54	23.8%	129	23%	176	23%
	Three times	15	6.6%	40	7%	70	9%

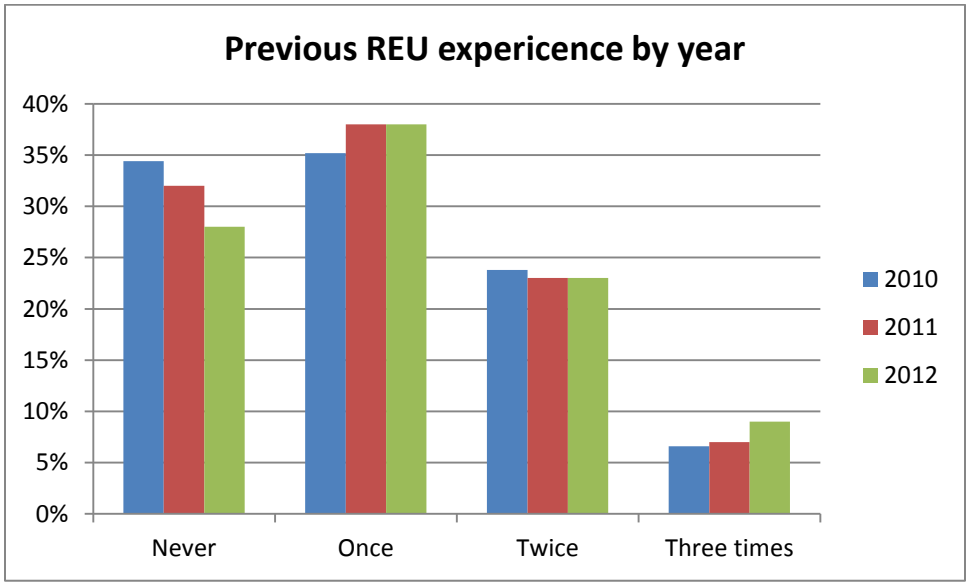
Figure 1 - 5 Trends in institutional and demographic characteristics of BIO-REU students.




Class standing by year
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
First year
Sophomore
Junior
Senior
Other
2010
2011
2012


Gender by year
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
2010
2011
2012
Female
Male


Race/ethnicity by year
70%
60%
50%
40%
30%
20%
10%
0%
Native American
Asian American
African American
Pacific Islander
White
Hispanic


Previous REU expericence by year
40%
35%
30%
25%
20%
15%
10%
5%
0%
Never
Once
Twice
Three times
2010
2011
2012

1.3 Core Items: Comparisons with other students and between years.

Four sections of the URSSA are used to measure the self-reported gains assessed at the end of students' REU experience. These items were developed from extensive interviews with REU students and assess perceived gains and benefits of participation in the REU. Core areas include *Thinking and Working Like a Scientist*, *Personal Gains*, *Skills* and *Scientific Attitudes and Behaviors.* Specific items and averages for each item are presented in tables 1.1 – 1.4 (see appendix) and show comparisons with the larger group of students taking the survey and between years. Averages computed over all the items in each section (core indicators) were used for statistical comparisons with the larger group, between years and demographic/academic status comparisons.

Differences in demographic and institutional factors between the REU years and other groups are controlled for during the analysis with a propensity analysis. This analysis first predicts if students are more likely to be a BIO-REU students or a non-BIO-REU students based on their demographic characteristics. After discovering any differences between groups, a value is assigned to the probability of group membership; these values are then is used to adjust for pre-existing differences between groups due to differences in their demographic and institutional characteristics. Appendix 1 presents this analysis. Comparison of average values between years, and with the other programs then used an Analysis of Variance using the propensity variable as a covariate.

The between year sample for 2011-2012 was also analyzed using a matched site sample. This analysis used only the universities and labs that administered the URSSA both years. Three-hundred seventy-two students were in matched labs in 2012, 304 students were from 2011.

Tables 5 and 6 show the comparisons between BIO-REU years and students in other programs. Asterisks denote significant differences between BIO-REU years.

*Significant difference between BIO-REU (either year)
^ Significant difference between year for BIO-REU group

Tables 5 and 6 presents the comparison between years for a matched sample of sites taking the survey both years. Overall, significant differences were evident for the comparison of BIO-REU groups with the non-BIO-REU group on all core indicators, but no significant differences were seen for any of the indicators between years for either the wider or matched samples. This means that students in BIO-REU score higher than students in non-BIO-REU programs, but that scores have not changed significantly over the three years of the survey.

Table 5 Comparison of all students and between years, non-matched sample.

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		2010	2011	2012	Non-BIO-REU
THINKING & WORKING LIKE A SCIENTIST	Mean	4.1	4.2*	4.2*	4.0*
	Standard Deviation	.8	.7	.65	.7
	Valid N	232	580	821	1119
PERSONAL GAIN	Mean	4.2	4.3*	4.3*	4.1*
	Standard Deviation	.85	.7	.67	.7
	Valid N	232	581	811	1115
SKILLS	Mean	3.9*	3.9*	3.96*	3.7*
	Standard Deviation	.9	.8	.75	.8
	Valid N	232	581	811	1113
ATTITUDES AND BEHAVIORS	Mean	4.2*	4.2*	4.24*	3.9*
	Standard Deviation	.7	.7	.75	.8
	Valid N	232	581	813	1105

*Significantly different at α = .05 level for comparison with other students

^Significantly different at α = 05 for comparison between BIO REU years

Figure 6 Core indicators for BIO-REU

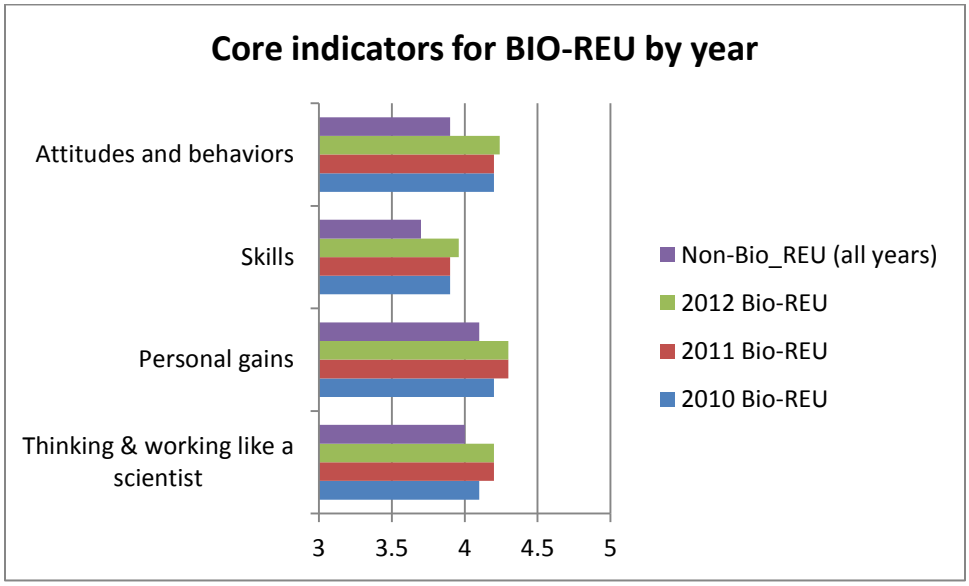


Table 6 Comparison of BIO REU years with matched sample: 2011 – 2012

		BIO REU 2011	BIO REU 2012	Non-BIO REU
THINKING & WORKING LIKE A SCIENTIST	Mean	4.2*	4.17*	4.0*
	Standard Deviation	.67	.67	.7
	Valid N	304	372	1119
PERSONAL GAIN	Mean	4.32*	4.24*	4.1*
	Standard Deviation	.67	.69	.7
	Valid N	304	392	1115
SKILLS	Mean	3.88*	3.91*	3.7*
	Standard Deviation	.83	.76	.8
	Valid N	304	392	1113
ATTITUDES AND BEHAVIORS	Mean	4.22*	4.19*	3.9*
	Standard Deviation	.73	.72	.8
	Valid N	304	395	1105

Note: *Significantly different at α = .05 level for comparison with other students

Note: ^Significantly different at α = 05 for comparison between BIO REU years

Note: Matched sample is by site, students are assumed to be independent between years.

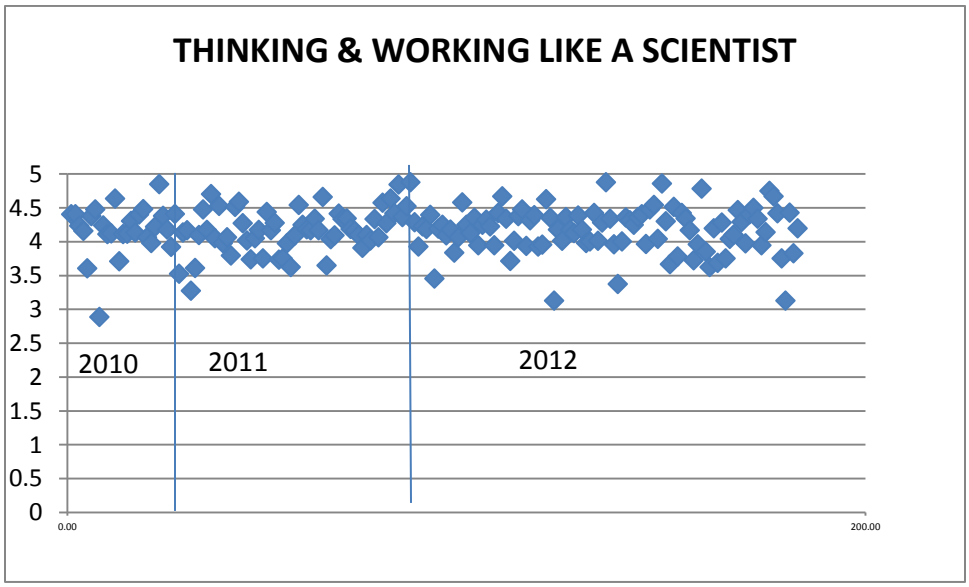
1.4 Core Items: Comparisons across sites.

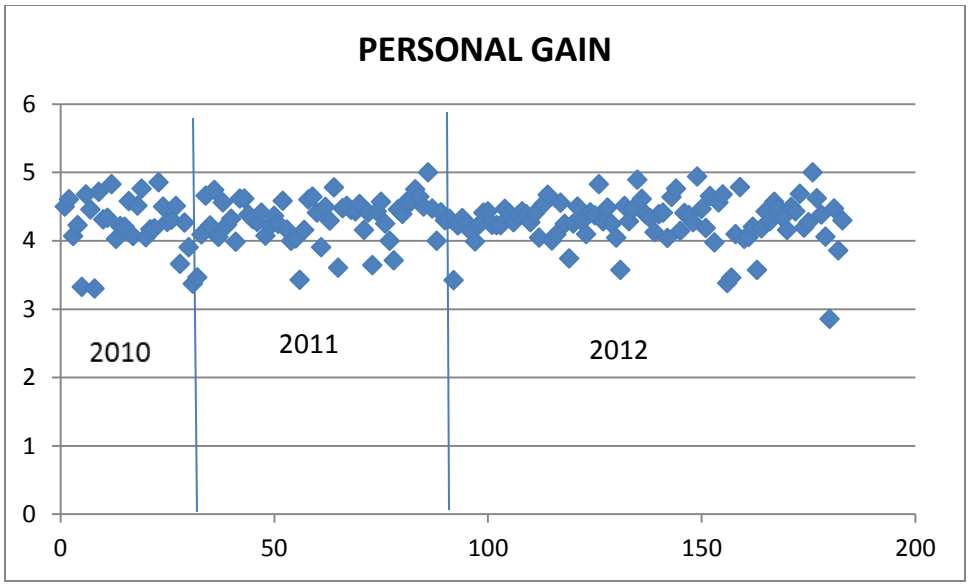
Averages on the core indicators were also calculated for each of the sites from 2010 -2012. Figures 7 - 10 shows the dispersion of averages by institution on these scores; specific sites are not identified by name.

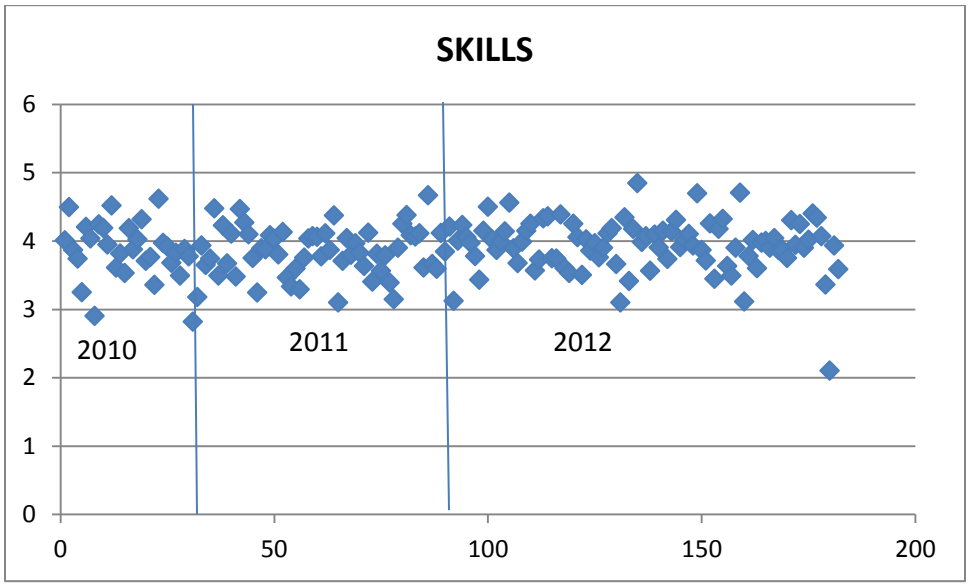
Examination of the figures suggests that students at most sites give similar ratings, although students at several sites collectively gave much lower average ratings. Overall, the site where a student participated in their REU explained 12% of the variability in their ratings, an amount typical for the dispersion of ratings for scores among multi-site studies such as schools in a district.

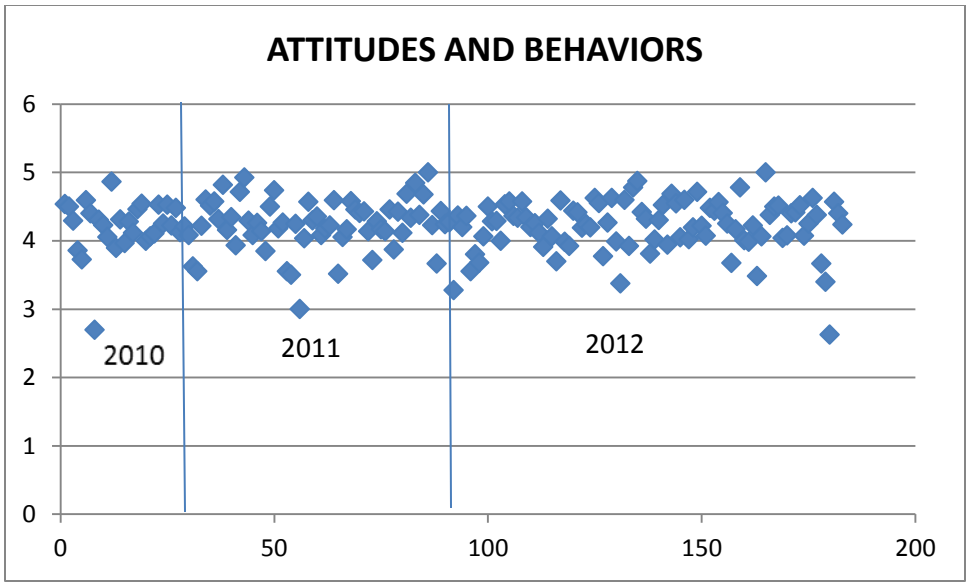
The figures indicate that most students at most institutions rate their learning highly. Lower average ratings are seen at only a handful of REU sites.

Figures 7 - 10 Dispersion of ratings for REU sites.




PERSONAL GAIN
6
5
4
3
2
1
0
2010
2011
2012
0
50
100
150
200


SKILLS
6
5
4
3
2
1
0
2010
2011
2012
0
50
100
150
200



1.5 Core Items: Institutional differences and "norms."

Information about institutional settings included *Public or Private Status*, *Size of Institution,* and *Carnegie Code Classification*. Other variables such as *Percentage of Minority Students, Percentage Gender*, *Percentage Academic Year*, and *Percentage of Students with Previous UR Experience* were also examined for the larger URSSA data set. All institutional variables were entered into linear regression and generalized linear models to determine if they predicted differences in the core outcome measures. Responses from 2012 were entered in the model and parameters were adjusted slightly, however differences appeared stable over years. Normative charts were then made that show the expected average values for all levels for these variables. These normative charts and comparisons are included in the appendix.

Significant predictors of core measures included *Carnegie Code Classification, Percentage of Minority Students, Public-Private Status, Institutional Size and Percentage Gender*, although not every predictor was significant with every core measure.

1.6 Core Items: Demographic and institutional differences.

Information about students including *Gender*, *Class Standing*, *Race/Ethnicity*, and *Previous Experience with REU's* were compared for students in the BIO-REU program. The tables summarize demographic differences for the core items found to be statistically significant.

Table 7 Significant demographic differences.

	Gender	Race/Ethnicity	Academic Year	Previous experience
Thinking and Working Like a Scientist	--			
Personal Gains	--	.3 Hispanic minus White		.3 Never minus more than three times
Skills	--	.26 Minority students minus White .3 Hispanic minus White		.3 Never minus more than 3 times
Attitudes and Behaviors	--			

Differences included 1) Hispanic students reported gaining more than Whites on the *Personal Gains* and *Skills* variables, and 2) students who had never participated in REU's said they gained more on *Personal Gains* and *Skills* than students who had attended three or more times. Levels for class standing and gender were not significantly different from each other.

2.0 Optional Sections for URSSA

2.1 Research Experiences

The first optional block of questions examined common research experiences for undergraduate students in REU's. These included more frequently reported activities such as presenting talks or posters to other students (91%), and less common activities such as attending conferences (31%) and writing journal articles (3%). BIO-REU students reported attending conferences more often than students in other programs, and planned to present and attend conferences at greater rates than students in other programs. Other differences were found for activities such as planning to present at conferences or talks. The between-year comparisons (both matched and unmatched) showed differences between years for presenting at conferences, with participation lower in 2011 and 2012 than in 2010. A greater proportion of students in 2012 presented posters or other presentation to peers than in 2011; proportionally fewer students in 2012 planned to apply for scholarships.

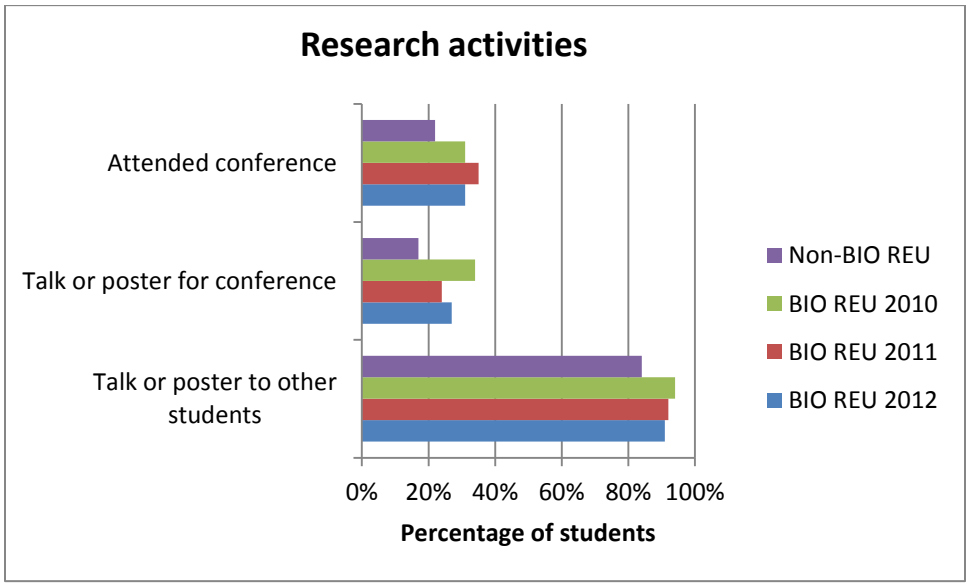
Table 8 Research experience for all students taking URSSA.

	BIO REU 2010	BIO REU 2011	BIO REU 2012	Non-BIO REU
I presented a talk or poster to other students or faculty	94%*	92%*	91%*	84%*
I presented a talk or poster at a professional conference	34%^*	24%^*	27%^*	17%*
I attended a conference	31%*	35%*	31%*	22%*
I wrote or co-wrote a paper that was published in an academic journal	4%	3%	3%	5%
I wrote or co-wrote a paper that was published in an undergraduate research journal	8%*	7%*	7%	13%*
I won an award or scholarship based on my research	5%*	3%*	6%*	11%*
I will write or cowrite a paper to be published in an undergraduate research journal	.	22%*	21%*	38%*
I will present a talk or poster at a professional conference	.	85%*	82%*	55%*
I will present a talk or poster to other students and faculty	.	41%*	46%*^	57%*
I will apply for an award or scholarship based on my research	.	53%*^	44%*^	32%*

Table 9 Research experiences for matched sample of BIO-REU students.

	2011	2012
I presented a talk or poster to other students or faculty	91%	92%
I presented a talk or poster at a professional conference	29%	31%
I attended a conference	40%	35%
I wrote or co-wrote a paper that was published in an academic journal	3%	4%
I wrote or co-wrote a paper that was published in an undergraduate research journal	11%	12%
I won an award or scholarship based on my research	3%	6%
I will write or cowrite a paper to be published in an undergraduate research journal	23%	21%
I will present a talk or poster at a professional conference	88%	83%
I will present a talk or poster to other students and faculty	47%	47%

Figure 14 Research activities.



2.2 Ratings of Satisfaction with the program.

Students rated their satisfaction with a range of program activities, support received from the program, and preparation for future education and work. Ratings of most activities were very high, with averages between 4 and 5.

Comparisons with other programs found that students in the BIO-REU program rated their mentors and activities with roughly the same satisfaction as did other students. For the general satisfaction item *rate your research experience overall* most sites averaged between ratings of 4 and 5, although some sites had much lower average ratings.

Table 10 Other Satisfaction Ratings.

	Program			
	BIO REU 2010	BIO REU 2011	BIO REU 2012	Non-BIO-REU
My working relationship with my research mentor	4.4	4.2*	4.2*	4.5*
My working relationship with research group members.	4.4	4.4	4.4	4.5
The amount of time I spent doing meaningful research.	4.3	4.3	4.3	4.3
The amount of time I spent with my research mentor.	4.0	4.0	4.0	4.1
The research experience overall.	4.5	4.5	4.5	4.6

Table 11 Satisfaction ratings matched sample 2011 - 2012.

	Year		
	BIO REU 2010	BIO REU 2011	BIO REU 2012
	Mean	Mean	Mean
My working relationship with my research mentor	4.5	4.3	4.3
My working relationship with research group members.	4.4	4.4	4.4
The amount of time I spent doing meaningful research.	4.3	4.3	4.2
The amount of time I spent with my research mentor.	4.0	4.0	4.0
The research experience overall.	4.6	4.5	4.5

Figure 15 Overall satisfaction by site 2012.

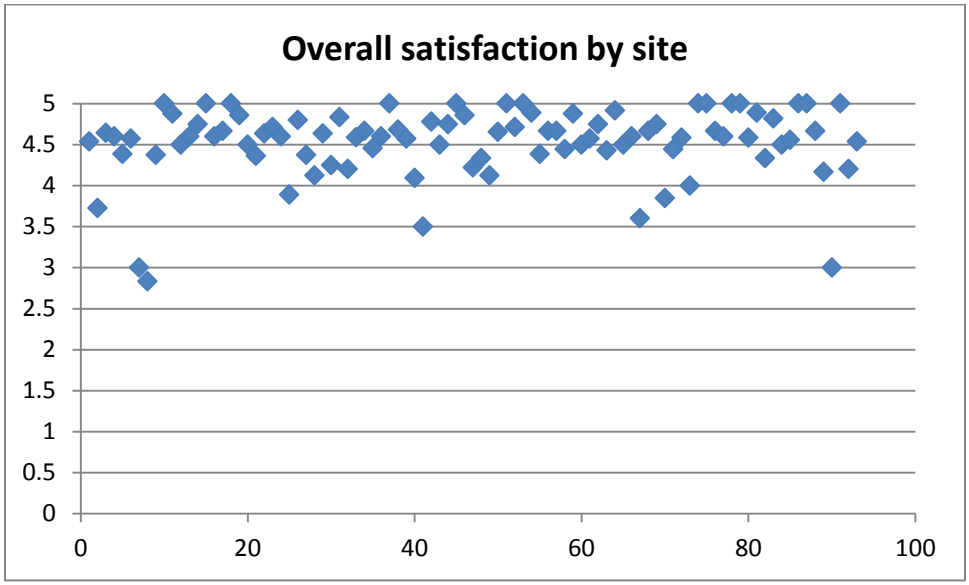


Table 12 Satisfaction with program.

How satisfied were you with: (1 - 5, Very dissatisfied – Very satisfied)	BIO-REU 2010	BIO-REU 2011	BIO-REU 2012	Non-BIO-REU
Information available to help me choose a research project.	4.1*	4.1*	4.0	3.6*
Support and guidance from program staff.	4.7*^	4.5^	4.6	4.5*
Support and guidance from my research mentor.	4.7	4.5	4.5	4.6
Support and guidance from other research group members.	4.5	4.6	4.5	4.6
Financial support.	4.7*	4.6*	4.65*	4.4*
Group social activities.	4.2	4.2	4.2	4.2
The application process.	4.4	4.5	4.4	
Lab or field equipment.	4.5	4.5	4.45	
Research group meetings.	4.1	4.1	4.1	

Note: Matched sample analysis not possible due to low numbers in some optional items.

Table 13 Preparation for education and other future endeavors

Agree/Disagree (1 – 5, Strongly Disagree – Strongly Agree)	BIO REU 2010	BIO REU 2011	BIO REU 2012	Non-BIO REU
Doing research confirmed my interest in my field of study.	4.2	4.2	4.2	4.2
My research experience has prepared me for graduate school.	4.3	4.4	4.4	4.3
My research experience has prepared me for a job.	4.1	4.2	4.2	4.1

2.3 Likelihood of future endeavors

The URSSA asks students if they were more likely to pursue educational or vocational paths after they completed the REU than before starting. The table compresses the original five response categories into three categories of responses: *Not at all likely*, *Slightly/Somewhat more likely*, and *Much more/Extremely more likely*.

Higher percentages are seen for the *much more/extremely more likely* for activities such as working in a science lab (51%), enrolling in a Master's program (41%), and enrolling in a Ph.D. program in science, mathematics and engineering (50%). Lower numbers of students responded that they were more likely to enroll in medical school (14%), or enroll in a program for a different professional degree (14%).

Student in the BIO-REU program were more likely to say they would enroll in a Ph.D program, enroll in a Master's program and work in a science lab than students in other programs, they also expressed more likelihood of entering medical school than the other students, although this probability went down significantly in 2012 for BIO-REU students. For the matched sample, students who said they were more likely to pursue either a Masters or Ph.D. degree in STEM went down significantly from 2011.

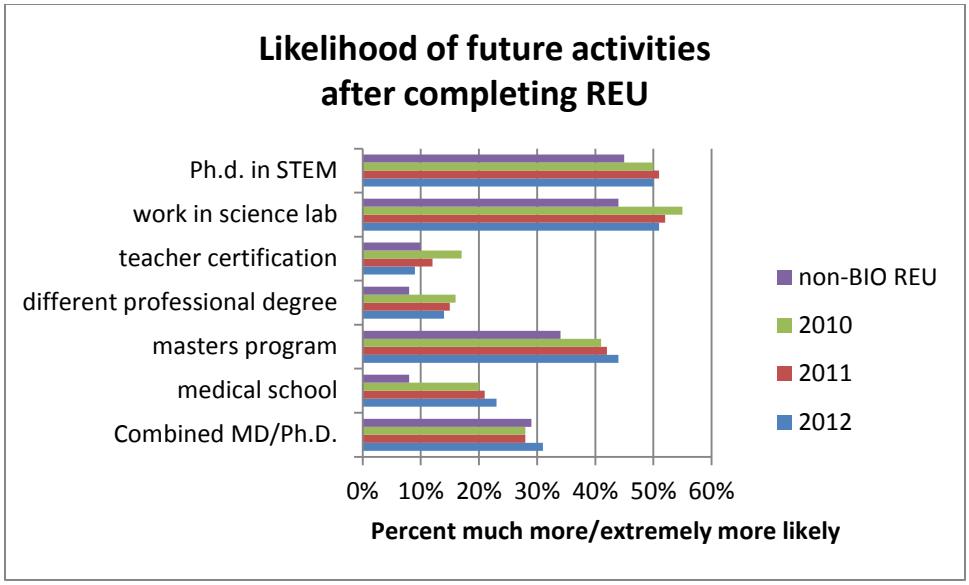
Table 14 Likelihood of intentions (% of all students).

Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:					
		BIO-REU 2010	BIO REU 2011	BIO REU 2012	Non-BIO-REU
…enroll in a Ph.D. program in science, mathematics or engineering?	Not at all likely	18%	21%	16%	21.3
	Slightly/somewhat more likely	31.5%	28%	34%	33.2
	Much more/Extremely more likely	50%*	51%*	50%*	45.5*
…enroll in a masters program in science, mathematics or engineering?	Not at all likely	33.5%	34%	33%	40.1
	Slightly/somewhat more likely	25%	24%	28%	26%
	Much more/Extremely more likely	41%*	42%*	44%*	34%*
… enroll in a combined M.D/Ph.D program?	Not at all likely	46%	48%	44%	49%
	Slightly/somewhat more likely	25%	23%	23%	22%
	Much more/Extremely more likely	28%	28%	31%	29%
… enroll in medical or dental school?	Not at all likely	67%	63%	62%	81%
	Slightly/somewhat more likely	12%	15%	15%	10%
	Much more/Extremely more likely	20%*	21%*	14%*^	8%*
…enroll in a program to earn a different professional degree (i.e. law, veterinary medicine, etc.)	Not at all likely	68%	69%	71%	79%
	Slightly/somewhat more likely	15%	15%	15%	12%
	Much more/Extremely more likely	16%*	15%*	14%*	7.9*
…pursue certification as a teacher?	Not at all likely	55%	61%	62%	64%
	Slightly/somewhat more likely	28%	27%	29%	25%
	Much more/Extremely more likely	17%^*	12%^	9%^	10%*
…work in a science lab?	Not at all likely	16%	17%	14%	20%
	Slightly/somewhat more likely	29%	31%	35%	35%
	Much more/Extremely more likely	55%*	52%*	51%*	44%*

Table 15 Likelihood of intentions (% of matched sample students).

Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:			
		2011	2012
…enroll in a Ph.D. program in science, mathematics or engineering?	Not at all likely	22%	18%
	Slightly/somewhat more likely	24%	34%
	Much more/Extremely more likely	54%	48%^
…enroll in a combined M.D/Ph.D program	Not at all likely	50%	47%
	Slightly/somewhat more likely	21%	23%
	Much more/Extremely more likely	29%	30%
…enroll in medical or dental school?	Not at all likely	61%	60%
	Slightly/somewhat more likely	15%	14%
	Much more/Extremely more likely	24%	26%
…enroll in a program to earn a different professional degree (i.e. law, veterinary medicine, etc.)	Not at all likely	70%	68%
	Slightly/somewhat more likely	16%	18%
	Much more/Extremely more likely	14%	15%
…enroll in a masters program in science, mathematics or engineering?	Not at all likely	35%	40%
	Slightly/somewhat more likely	22%	26%
	Much more/Extremely more likely	43%	34%^
…pursue certification as a teacher?	Not at all likely	59%	62%
	Slightly/somewhat more likely	27%	28%
	Much more/Extremely more likely	14%	9%^

Figure 16 Likelihood of future activities after completing REU.



2.4 Hours per week engaged in activities

Students were asked to report how many hours they spent talking per week with their research mentor. Forty-one percent reported spending four or more hours, 38% reported this amount in 2011. In 2011, 77% reported spending four or more hours per week talking with others in their lab; in 2012 this was 73%.

Table 16 Frequency of activities

		BIO-REU 2010		BIO-REU 2011		BIO REU 2012	
On average, how many hours per week did you spend talking with your most recent research mentor?	None	7	4%	12	3%	29	5%
	One	32	19%	93	22%	109	19%
	Two	38	22%	80	19%	115	20%
	Three	17	9%	67	16%	84	15%
	Four or more	78	45%	160	39%	233	41%
How many hours per week did you work at research-related activities in your most recent research experience?	None			18	5%	24	4%
	One			28	7%	69	11%
	Two			12	3%	29	5%
	Three			28	7%	42	7%
	Four or more			294	77%	439	73%

3.1 Student answers to open-ended questions.

Students answered open-ended questions about several topics. The survey asked students to 1) describe other gains from the research not included in the ratings questions, 2) how the research influenced their future work and graduate school plans, and 3) how the program could be improved. Categories of student responses are found in the tables below (tables).

Five-hundred-eighty-nine (589) students responded to the first question:
Did you make other gains from doing research that we didn't mention? If so, please briefly describe these. Most frequently cited benefits (23%) included networking with peers, mentors, other researchers on campus and graduate students. Students also reported learning specific skills such as lab techniques, data analysis, computer skills, and personal skills such as time management. Other areas mentioned were familiarization with practical scientific activities (7%) and clarification of plans for the future (12%).

Seven-hundred-seventy (770) students answered the question: *How did your research experience influence your thinking about future career and graduate school plans? Please explain.* Twenty-one percent of students in 2010, 26% in 2011 and 32% in 2012 said their experience confirmed or strengthened an existing decision to attend graduate school. **The percentage of students who said they changed their mind during the REU and want to attend graduate school was 22%.** Another 31% said that the experience had provided them with important information about graduate school or allowed them to understand more of the reality of conducting scientific research, thus giving them a better basis for making a choice about continuing their education. Only 3% said that participating in the REU had changed their mind about continuing in the science.

URSSA also asked students how they would improve their REU experience (*What would have made your research experience better?).* Five hundred students answered this question. Seventeen percent (2010), 16% (2011) and 11% in 2012 answered they wanted more time with their mentors and their mentors more involved in the students' research. Other concerns focused on changing activities specific to an REU such as students wanting more field trips, different speakers, better seminar topics, and more chances to present scientific findings. Ten percent of students said they wanted the REU to provide more or better information about graduate school or the graduate school application process.

Other concerns by year included:

- *Scheduling*; (12%, 18%, 22%) not having enough time during the summer session to complete projects.
- *Logistics*: (6%, 4%, 2%) concerns with housing or transportation.
- *Organization*: (11%, 1%, 2%) Lack of organization with lab activities, guidance in getting started, "dead time" during the daily schedule.

Table 17: *Did you make other gains from doing research that we didn't mention? If so, please briefly describe these.*

	% 2010	% 2011	% 2012	Example
Networking, meeting new people, graduate students, mentors	25%	26%	*23%*	*It was really positive to meet so many female professors. It made me feel good about my future in science to see women doing high level work and supporting such an amazing department.* *Networking with peers/future scientist and faculty*
Specific skills	23%	21%	*18%*	*I became much more familiar with lab techniques and actually applying what I learned in class to what I used in the labs.* *Data management and putting data into a useful form.* *I gained how to analyze data, and be able to think critically.*
Increased confidence, other personal gains	17%	14%	*12%*	*I feel a lot more confident in my ability to conduct independent scientific research.*
Learned about practical aspects of science	12%	8%	*7%*	*I gained some insight into the daily tasks of a researcher* *I learned very quickly that as a researcher you will have to schedule around your experiments and that if it comes down to it to put in extra hours. Whether it be working late into the night or even on weekends.*
Clarified Plans for the Future/ Learned about graduate school	9%	3%	*12%*	*I realized that if I do choose to pursue a PhD, then I would like to pursue it in the field of cancer biology.* *Knowledge about more post-graduate options.*
General positive comments	6%	1%	*0%*	*Met wonderful people and became involved in amazing projects I expect to continue doing and collaborating with!*

(cont.)

Learned about how science works	3%	8%	*9%*	*I learned that biophysics is very similar to chemistry, and that I like it even more!* *I gained a good understanding about what research is really about.*
General negative comments	3%	1%	*1%*	*No, the research was not intellectually challenging or very engaging. My mentor even said to me that the study was a "no-brainer" during one of our first weeks together. I did not find my research very meaningful and my mentor was unable to convince me that it was meaningful or relevant research.*
Learned importance of mentor	1%	2%	*4%*	*I realized how important it is to have a good mentor when going to grad school. Before I thought it was all about the school or the strength of a particular program at a school, but this summer research experience really made me realize the importance of having a good mentor who you get along with.* *Getting to know different mentor styles and figuring out what works best for me.*

Table 18: *How did your research experience influence your thinking about future career and graduate school plans? Please explain.*

	% 2010	% 2011	% 2012	Example
Confirmed existing plans for going to graduate school	21%	26%	32%	*It confirmed that I want to continue on to graduate school.*
Changed mind and will attend graduate school	20%	14%	22%	*My research influenced me to want to pursue a PhD and get a career doing research.*
Provided better information about graduate school so can make a more informed decision	20%	26%	31%	*It helps me narrow down which path i want to follow. More specifically it helps me narrow which sector of science i'd like to pursue a PhD in.*
Changed mind about vocation, will get a job in science	10%	7%	2%	*It made me realize that a career in science is definitely what I wish to pursue.*
No change in plans	10%	6%	2%	*Not much. Plans remain to attend Graduate school.*
Changed mind about going to graduate school, will not go	9%	7%	5%	*This research has given me direction in the fact that I have realized that I do not want to do research but would be much happier in industry. I plan on obtaining a Professional Sciences Masters degree.*

(cont.)

Gave me confidence to know I can go to graduate school	4%	4%	3%	*It made me much more excited for the opportunities I have in the future.*
Will go to medical school	1%	1%	1%	
Off topic	3.2	--		

Table 19: *What would have made your research experience better?*

Category	% 2010	% 2011	% 2012	Example
Nothing needed to change, good as it was	30%	30%	29%	
Wanted mentor more involved in work, more accessible, more time with mentor	17%	16%	*11%*	*If my mentor was more enthusiastic and excited about the research I was doing. If she was available to answer my questions* *Find mentors that actually enjoy mentoring undergraduates and have very hard-working, yet kind attitudes.*
Wanted to do different activities or learn different skills, wanted to modify existing activities	13%	12%	*29%*	*Maybe more presentations on our research throughout the summer versus only having the big presentation at the end.* *More opportunities to present research*
Scheduling; not enough time to complete work	12%	18%	*22%*	*Having more time to think and learn. Less rushing for results. We would have gone further if we had not rushed everything.* *The workshops were way too long. All the material covered in the workshops could have taken half the time or less….*
Lab disorganized, needed activities better organized	11%	1%	*2%*	*Maybe more organization. I was never really sure when I had to be certain places or do certain places with the other REU students.*
Logistical problems in transportation, housing, payment.	6%	4%	*2%*	*Having a car, or some reliable means of transportation.* *In the future some sort of option for a meal plan would be a good idea as well.*

(cont.)

Wanted better relationships with peers, more opportunities to network with peers or graduate students.	5%	9%	*13%*	*More motivated and excited participants...in some cases.* *Maybe having a social event with the grad students?*
Needed more information about the REU program, wanted more information about graduate school	4%	7%	*10%*	*Needed a session on graduate school programs.* *The mentor/project selection during application process needs to have be much more specific. The only information I could use from my mentor's online page about which project I would do was looking at his publciations and basing my guess on that. There was no clear cut as to what exactly I would have been researching and I suffered from that.*
Insufficient resources	1%	3%	*1%*	*Having more instruments to work with...like a PCR machine for example.* *Needed more money for better facilities.*

Appendix: Supplementary Tables

Table 1.1 Thinking and Working Like a Scientist

How much did you GAIN in the following areas as a result of your most recent research experience? (Five point scale: No gains – Great gains)	BIO REU 2010	BIO REU 2011	BIO REU 2012	Other Programs
Analyzing data for patterns.	4.00	4.03	4.07	3.87
Figuring out the next step in a research project.	4.16	4.21	4.21	4.13
Problem-solving in general.	4.19	4.17	4.23	4.06
Formulating a research question that could be answered with data.	3.95	4.08	4.03	3.82
Identifying limitations of research methods and designs.	4.21	4.26	4.23	4.25
Understanding the theory and concepts guiding my research project.	4.43	4.44	4.43	4.31
Understanding the connections among scientific disciplines.	4.05	4.12	4.13	4.18
Understanding the relevance of research to my coursework.	4.10	4.17	4.18	3.91

Table 1.2 Personal Gains

How much did you GAIN in the following areas as a result of your most recent research experience? (Five point scale: No gains – Great gains)	BIO REU 2010	BIO REU 2011	BIO REU 2012	Other Programs
Confidence in my ability to contribute to science.	4.21	4.17	4.27	4.03
Comfort in working collaboratively with others.	4.21	4.21	4.22	4.11
Confidence in my ability to do well in future science courses.	4.29	4.23	4.24	3.96
Ability to work independently.	4.31	4.33	4.32	4.20
Developing patience with the slow pace of research.	4.07	4.11	4.16	4.05
Understanding what everyday research work is like.	4.48	4.59	4.52	4.45
Taking greater care in conducting procedures in the lab or field.	4.30	4.36	4.37	4.20

Table 1.3 Skills

How much did you GAIN in the following areas as a result of your most recent research experience? (Five point scale: No gains – Great gains)	BIO REU 2010	BIO REU 2011	BIO REU 2012	Other Programs
Writing scientific reports or papers.	3.78	3.78	3.73	3.44
Making oral presentations.	4.10	4.10	4.13	4.02
Defending an argument when asked questions.	3.77	3.71	3.81	3.62
Explaining my project to people outside my field.	4.24	4.21	4.26	4.15
Preparing a scientific poster.	4.11	4.05	4.18	3.94
Keeping a detailed lab notebook.	3.96	3.74	3.87	3.72
Conducting observations in the lab or field.	4.06	3.99	4.09	3.89
Using statistics to analyze data.	3.52	3.43	3.47	3.13
Calibrating instruments needed for measurement.	3.41	3.42	3.50	3.42
Understanding journal articles.	3.94	3.88	3.88	3.81
Conducting database or internet searches.	3.69	3.76	3.67	3.58
Managing my time.	3.87	3.94	3.98	3.59

Table 1.4 Attitudes and Behaviors

During your research experience HOW MUCH did you: (Five point scale: None – a great deal)	PROGRAM			
	BIO REU 2010	BIO REU 2011	BIO REU 2012	Other Programs
Engage in real-world science research	4.59	4.62	4.60	4.48
Feel like a scientist.	4.41	4.37	4.43	4.31
Think creatively about the project.	4.22	4.20	4.24	4.05
Try out new ideas or procedures on your own.	3.67	3.74	3.75	3.73
Feel responsible for the project.	4.45	4.50	4.50	4.32
Work extra hours because you were excited about the research.	4.03	4.08	4.10	3.81
Interact with scientists from outside your school.	3.95	4.08	4.03	3.90
Feel a part of a scientific community.	4.33	4.35	4.28	4.19

Table 1.5 Class standing and averages for composite variables (2012)

	Class Standing				
	Freshman	Sophomore	Junior	Senior	Other
	Mean	Mean	Mean	Mean	Mean
Thinking and Working Like a Scientist	4.02	4.19	4.16	4.26	4.19
Personal gains	4.20	4.30	4.24	4.39	4.24
Skills	3.89	3.96	3.87	4.04	3.89
Attitudes and Behaviors	4.22	4.15	4.25	4.34	3.83

Table 1.6 Gender and averages for composite variables

	Gender	
	Female	Male
	Mean	Mean
Thinking and Working Like a Scientist	4.21	4.20
Personal gains	4.34	4.25
Skills	3.98	3.94
Attitudes and Behaviors	4.26	4.22

Table 1.7 Race/Ethnicity and averages for composite variables

	Black	Asian	White	Hispanic
	Mean	Mean	Mean	Mean
Thinking and Working Like a Scientist	4.29	4.29	4.13	4.38
Personal gains	4.42	4.47	4.22	4.52
Skills	4.12	4.14	3.85	4.19
Attitudes and Behaviors	4.29	4.36	4.20	4.37

Table 1.8 Logistic regression model for propensity analysis.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	CC Baccalaureate	-1.580	.300	27.697	1	.000	.206
	Public/Private	-.731	.097	56.320	1	.000	.481
	Percentage White	-3.786	.243	242.325	1	.000	.023
	Percentage fourth year	-.287	.119	5.852	1	.016	.750
	Research One	-1.097	.149	54.344	1	.000	.334
	Constant	3.827	.294	169.399	1	.000	45.923

- Dependent variable is BIO-REU membership coded 1, other students coded 0.
- Site is unit of measurement.

	Carnegie Code	Public/Private	Size	Percentage Minority	Percentage Gender
4.9					
4.8					
4.7					
4.6					
4.5					
4.4					
4.3					
4.2	MASTERS (LARGE) INSTITUTE/PRIVATE LAB	INDEPENDENT	5000 - 10000	Over 75% 50 - 75%	0 -25% MALE 76 -100% MALE
4.1	R1 DOCTORAL GRANTING MASTERS (MEDIUM)	PUBLIC PRIVATE	10000- 20000 Over 20000		26% - 50% MALE 51 - 75% MALE
4.0			Under 5000	25-50%	
3.9	BAC A & S			Under 25%	
3.8					
3.7					
3.6					
3.5					

PERSONAL GAINS

	Carnegie Code	Public/Private	Size	Percentage Minority	Percentage Gender
4.9					
4.8					
4.7					
4.6					
4.5					
4.4	MASTERS (LARGE)				0 -25% MALE
4.3				Over 75%	
	DOCTORAL GRANTING			50 - 75%	
4.2					26% - 50%
	MASTERS (MEDIUM)				MALE
		PUBLIC			
	R1				51 - 75% MALE
		PRIVATE	Over 20000		
	INSTITUTE/PRIVATE				76 -100%
	LAB	INDEPENDENT	10000- 20000		MALE
4.1			Under 5000		
	R1		5000 - 10000	25-50%	
4.0	BAC A & S			Under 25%	
3.9					
3.8					
3.7					
3.6					
3.5					

SKILLS

	Carnegie Code	Public/Private	Size	Percentage Minority	Percentage Gender
4.9					
4.8					
4.7					
4.6					
4.5					
4.4					
4.3					
4.2					
4.1					
4.0					
3.9	MASTERS (LARGE)			Over 75% 50 - 75%	0 -25% MALE
3.8	DOCTORAL GRANTING MASTERS (MEDIUM) R1	PRIVATE PUBLIC	10000- 20000 Over 20000		26% - 50% MALE 51 - 75% MALE
3.7	INSTITUTE/PRIVATE LAB BAC A & S	INSTITUTION /PRIVATE LAB	Under 5000	25-50%	
3.6			5000 – 10000	Under 25%	76 -100% MALE
3.5					

ATTITUDES AND BEHAVIORS

	Carnegie Code	Public/Private	Size	Percentage Minority	Percentage Gender
4.9					
4.8					
4.7					
4.6					
4.5					
4.4		PRIVATE INSTITUTION			
4.3					
4.2	MASTERS (LARGE)			Over 75% 50 - 75%	0 -25% MALE
4.1	INSTITUTE/PRIVATE LAB R1	 PUBLIC PRIVATE	5000 – 10000 10000-20000 Over 20000		26% - 50% MALE 51 - 75% MALE 76 -100% MALE
4.0	DOCTORAL GRANTING MASTERS (MEDIUM)			25-50%	
3.9			Under 5000		
3.8				Under 25%	
3.7					
3.6					