

2010 BIO REU URSSA Pilot Assessment Report

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In the summer of 2010, we asked the BIO REU community to use a pilot assessment instrument in order to gather information about common outcomes of our programs and to establish a baseline data set that we can use to determine the efficacy of our efforts. This pilot instrument contained core questions from the original URSSA survey and some questions specific to the BIO REU program.

This report includes an executive summary, an overview of the core findings and some concluding remarks.

Executive Summary

Two hundred and thirty-two (232) students at 28 NSF-funded BIO REU sites at 23 institutions took the Undergraduate Research Student Self Assessment (URSSA) survey as part of a pilot study conducted during Summer 2010. These students primarily came from public institutions (83%), were either Juniors and Seniors (64%), with 46% White, 26% African American and 17% Hispanic. The majority were female (61%).

Sixty percent of students participating in the BIO-REU program had participated in academic year research; 34% had previously completed at least one summer research experience.

The URSSA is a self-report survey instrument intended for use by undergraduate research program administrators for program-level evaluation of student outcomes (Hunter, Weston, Laursen & Thiry, 2009). The instrument is thus well suited to settings such as BIO REU programs where undergraduates participate in mentored research in multiple, independent laboratories. URSSA questions ask students to report their gains in four main areas: *Thinking and Working Like a Scientist*, *Personal Gains*, *Skills* and *Scientific Attitudes and Behaviors*. Other questions relate to elements of the undergraduate research (UR) experience that are important for student learning, students' satisfaction with the program and its particular components, motivation for participating, and demographic information.

We averaged ratings across questions within each core gains area and compared with ratings from students from other, non-BIO REU UR programs who took the original URSSA survey. This comparison showed higher overall ratings for students in the BIO-REU program in two of the core gains areas, *Personal Gains* and *Scientific Attitudes and Behaviors*, and equivalent gains in the other two core areas.

Demographic analysis of the composite gains variables showed:

- Students at private institutions reported gaining more than did students at public institutions
- First Year and Sophomore students reported gaining more than Seniors
- Minority students (especially African-Americans) gained more than Whites
- Students from homes where parents did not finish high school reported gaining more than students whose parents held advanced degrees.

Results from the URSSA also showed:

- BIO-REU students reported attending conferences (31%) more often than did students in other programs.
- BIO-REU students rated *the amount of time I spent doing meaningful research* (4.35) and *the amount of time I spent with my research mentor* (4.30) significantly higher than did students from other UR programs.
- BIO-REU students primarily learned about the REU from announcements (63%), the NSF website (60%) and academic advisors (60%).
- BIO-REU students stated that, after they had completed their REU, they were *much more/extremely more likely* to engage in activities such as working in a science lab (54%), completing a bachelor's degree in science (62%), and enrolling in a Ph.D. program in science, mathematics or engineering.

Data highlights

Table 1 shows demographic information for students who participated in the pilot assessment.

Table 1. Demographics of BIO REU URSSA survey respondents in summer 2010

Demographic variable and group		Count	%
Class standing	Freshman/Rising Sophomore	19	8.2%
	Sophomore/Rising Junior	54	23.3%
	Junior/Rising Senior	88	37.9%
	Senior	71	30.6%
Race/ethnicity	White	73	41.5%
	African-American	46	26.1%
	Asian-American	8	4.5%
	Native American	12	6.8%
	Pacific Islander	6	3.4%
	Hispanic (not white)	31	17.6%
Gender	Male	89	38.5%
	Female	142	61.5%
GPA (on a 4-point scale)	below 2.0	0	0.0%
	2.0 -2.32	3	1.3%
	2.33 - 2.66	4	1.7%
	2.67 - 2.99	15	6.5%
	3.0 - 3.32	42	18.1%
	3.33 -3.66	68	29.3%
	3.67 - 4.0	100	43.1%

Core gains items: Comparisons with other undergraduate research students

Four sections of the URSSA are used to measure self-reported gains assessed at the end of students' REU experience. These items were developed from extensive interviews with undergraduate research students (Seymour, Hunter, Laursen & DeAntoni, 2004; Hunter, Laursen & Seymour, 2007; Laursen et al., 2010) to 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*. Weighted averages computed over all the items in each section (composite variables) were used for statistical comparisons with the larger group and demographic/academic status comparisons. Table 2 shows the comparison between BIO-REU and students in other undergraduate research (UR) programs who completed the original URSSA. Scores on the scales for *Personal Gains* and *Attitudes and Behaviors* are significantly higher for students in the BIO-REU program.

Table 2. Adjusted Means, Standard Deviations and Sample Sizes for Composite Gains Variables for Students in BIO REU and other Undergraduate Research (UR) Programs (scale 1 to 5)

		BIO REU	Other UR Programs
Thinking & working like a scientist (adjusted mean)	Mean	4.02	3.91
	SD	1.00	1.00
	N	231	782
Personal gains (adjusted mean)	Mean	4.29*	4.11
	SD	1.01	0.97
	N	238	799
Skills (adjusted mean)	Mean	3.87	3.77
	SD	1.00	1.00
	N	176	785
Attitudes & behaviors of a scientist (adjusted mean)	Mean	4.21**	3.86
	SD	1.02	1.02
	N	235	739

*Difference significant at $p < .05$, ** $p < .01$.

Means are adjusted for demographic differences between groups.

UR: Undergraduate Research

The composite items in Table 2 are adjusted statistically for differences in the demographic characteristics of students in each program. If you are making a comparison with a simple average computed for all the items in one section, your results may differ from the adjusted score if your students differ in some substantial way than students in the general population (see Table 1). Tables A.1-A.4 in the Appendix show the simple means (not adjusted for population) for individual items in each of the four core gains areas. These tables also indicate the grouping of items used to compute the composite items.

Core gains items: Demographic differences

Information about students included *Gender, Class Standing, Race/Ethnicity, GPA and Parental Education* and if they completed their undergraduate research experience at a public or private institution. Table 3 summarizes gains score differences by demographic group, for the composite core items where differences were found to be statistically significant. The numbers show the differences (on a five-point scale) for each group; for example, “0.21 Private - Public” indicates that students at private institutions rated their gains on average 0.21 higher than students at public institutions.

Some of the differences may seem surprising. These included

- 1) students at private institutions reported gaining more than did students at public institutions,
- 2) First-year and Sophomore students reported gaining more than Seniors,
- 3) Minority students (especially African-Americans) reported gaining more than Whites, and

- 4) students from homes where parents did not finish high school reported gaining more than students whose parents held advanced degrees.

Gender and college GPA did not correlate with gains for these items.

Table 3. URSSA gains score differences for BIO REU students, by demographic group

	Institution Type	Gender	Class Standing	Race/Ethnicity	GPA	Parental Education
Thinking & Working Like a Scientist	0.21 Private - Public	--	--	0.56 AfrAm - White	---	0.67 No HS - Ph.D.
Personal Gains	0.28 Private - Public	--	0.40 Sophomore - Senior	0.55 AfrAm - White	0.22 High - low	0.54 No HS - Ph.D.
Skills	--	0.15 female - male	0.43 Freshman - Senior	0.65 AfrAm - White	---	0.63 No HS - Ph.D.
Scientific Attitudes & Behaviors	0.57 Private - Public	--	0.42 Freshman - Senior	0.37 AfrAm - White	---	0.39 No HS - Ph.D.

Differences on a five point scale

Optional Sections of URSSA

Students' Research Experiences

The first optional block of questions examined common research experiences for undergraduate research students (Table 4). These are known to be important, formative experiences for students within a UR experience (Laursen et al., 2010). These included more frequently reported activities such as presenting talks or posters to other students, and less common activities such as attending conferences and writing journal articles. BIO-REU students reported attending conferences (31%) more often than students in other UR programs, and planned to present and attend conferences at greater rates than students in other UR programs.

Table 4. Percentage of students from BIO REU and other undergraduate research programs reporting particular research-related experiences

As part of my most recent research experience...	BIO REU	Other UR Programs
	Percentage responding yes	Percentage responding yes
I presented a talk or poster to other students or faculty	94%	95%
I presented a talk or poster at a professional conference	34%*	16%
I attended a conference	31%*	23%
I wrote or co-wrote a paper that was published in an academic journal	4%	2%
I wrote or co-wrote a paper that was published in an undergraduate research journal	8%	6%
I will present a talk or poster to other students and faculty	81%	72%
I will present a talk or poster at a professional conference	52%*	22%
I will write or co-write a paper to be published in an academic journal.	31%	35%
I will write or co-write a paper to be published in an undergraduate research journal.	28%*	13%
I won an award or scholarship based on my research	5%	4%

Student ratings of satisfaction with their undergraduate research program

Students rated their satisfaction with a range of program activities, support received from the program, and preparation for future education and work. Tables 5-7 summarize these results.

Ratings of most activities were very high, with averages between 4 and 5. Lower ratings were seen for the item: *My research experience has clarified for me that I do not wish to pursue a career in scientific research*, for some activities such as training for internet or library searches, and for training for human subjects research. Some of these activities were only carried out at a small number of sites.

Comparisons with other undergraduate research programs found that students in the BIO REU programs rated *the amount of time I spent doing meaningful research* (4.35) and *the amount of time I spent with my research mentor* (4.30) significantly higher than did students from other UR programs. Students also rated activities such as support and guidance about their research projects more highly, as well as the financial support given by the program. For the general satisfaction item, *rate your research experience overall*, most BIO REU sites averaged between ratings of 4 and 5.

Table 5. Satisfaction ratings for BIO REU and other undergraduate research programs

Ratings (scale 2 - 5, Poor, Fair, Good, Excellent)	BIO REU	Other UR Programs
	Mean	Mean
My working relationship with my research mentor	4.60	4.53
My working relationship with research group members.	4.53	4.51
The amount of time I spent doing meaningful research.	4.35*	4.19
The amount of time I spent with my research mentor.	4.30*	4.13
The advice my research mentor provided about careers or graduate school.	4.34	4.30
The research experience overall.	4.60	4.56
My relationship with the other summer undergraduate research students in the program.	4.44	.
Ease in locating a research mentor	4.37	.
Ease in securing a research position.	4.49	.
Field trips	3.46	.

Some satisfaction items were included in the BIO REU survey, but not in the survey used by other UR programs.

Table 6. Satisfaction with program, for BIO REU and other UR students

How satisfied were you with: (2 - 5, Very dissatisfied – Very satisfied)	BIO REU	Other UR Programs
	Mean	Mean
Information available to help me choose a research project.	4.10*	3.57
Support and guidance from program staff.	4.70*	4.50
Support and guidance from my research mentor.	4.68	4.66
Support and guidance from other research group members.	4.50	4.59
Financial support.	4.76*	4.36
Group social activities.	4.28	4.20
The application process.	4.41	.
Lab or field equipment.	4.56	.
Research group meetings.	4.16	.
Field trips.	3.82	.
Workshop(s) on science writing and presentation.	3.63	.
Training in library/internet/database search methods.	2.71	.
Safety training	3.66	.
Ethics seminar(s)	3.99	.
Training in human or animal subjects regulations.	2.46	.
Session(s) offered on graduate school programs or careers.	3.17	.
Information provided by my research mentor.	3.84	.
Information from other research group members.	3.96	.

Table 7. Preparation for education and future endeavors, for BIO REU and other UR students

Statements about future plans (2 – 5, Strongly Disagree – Strongly Agree)	BIO REU	Other UR Programs
	Mean	Mean
Doing research confirmed my interest in my field of study.	4.21	4.22
Doing research clarified for me which field of study I want to pursue.	4.16	4.18
My research experience has prepared me for advanced coursework or thesis work	4.25	4.19
My research experience has prepared me for graduate school.	4.27	4.40
My research experience has prepared me for a job.	4.07	4.06
My research experience has prepared me to transfer from a 2-year to a 4-year institution.	3.38	.
My research experience has clarified for me that I do not wish to pursue a career in scientific research.	2.72	.

Students' reasons for participating in undergraduate research

A large majority of students chose many of the provided options for reasons for attending the program. These included exploring their interest in science (96%), gaining hands on experience (99%) and having a good intellectual challenge (93%) (Table 8). Fewer students were drawn to programs because of specific professors (48%).

Table 8. Reason for doing research, for students in BIO REU and other UR students

I wanted to do research to:	BIO REU	Other UR programs
	Percentage responding "yes"	
...explore my interest in science	96%	96%
...gain hands-on experience in research	99%	99%
...clarify which field I wanted to study	86%	88%
...clarify whether graduate school would be a good choice for me	83%	82%
... clarify whether I wanted to pursue a science research career	84%	84%
... have a good intellectual challenge	96%	93%
....work closely with a particular faculty member	48%	46%
...participate in a program with strong reputation	75%	81%
... get good letters of recommendation	75%	77%
.... enhance my résumé	91%	92%

Changes in likelihood of students' planned future endeavors

The URSSA asks students if they were more likely to pursue educational or vocational paths after they completed the REU than before they started the REU. Table 9 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*.

Table 9. Likelihood of educational and career intentions following a research experience

Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:		BIO-REU	Other UR Programs
		% of students reporting	
...enroll in a Ph.D. program in science, mathematics or engineering?	Not at all likely	18.3	21.3
	Slightly/somewhat more likely	31.5	33.2
	Much more/Extremely more likely	50.2	45.5
...enroll in a masters program in science, mathematics or engineering?	Not at all likely	33.5	40.1
	Slightly/somewhat more likely	25.6	25.9
	Much more/Extremely more likely	40.9	33.9
... enroll in a combined M.D/Ph.D program	Not at all likely	46.5	48.8
	Slightly/somewhat more likely	24.8	21.9
	Much more/Extremely more likely	28.6	29.4
... enroll in medical or dental school? *	Not at all likely	67.2	81.5
	Slightly/somewhat more likely	12.5	10.3
	Much more/Extremely more likely	20.4	8.2
...enroll in a program to earn a different professional degree (i.e. law, veterinary medicine, etc.)	Not at all likely	68.1	79.5
	Slightly/somewhat more likely	15.4	12.6
	Much more/Extremely more likely	16.4	7.9
...pursue certification as a teacher?	Not at all likely	55.3	64.4
	Slightly/somewhat more likely	28.1	25.1
	Much more/Extremely more likely	16.6	10.4
...work in a science lab? **	Not at all likely	16.3	20.2
	Slightly/somewhat more likely	29.1	35.4
	Much more/Extremely more likely	54.6	44.4
...complete your Associates degree?	Not at all likely	0	21
	Slightly/somewhat more likely	42.9	34.2
	Much more/Extremely more likely	57.2	44.7
... transfer to a 4-year institution?	Not at all likely	0	12.9
	Slightly/somewhat more likely	37.5	36.6
	Much more/Extremely more likely	62.5	50.5
...complete your Bachelors degree in science, mathematics or engineering?	Not at all likely	25	20.6
	Slightly/somewhat more likely	12.5	39.2
	Much more/Extremely more likely	62.5	40.2

Differences are significant at $p < 0.05$; ** at $p < 0.01$

High percentages are seen for the *much more/extremely more likely* response for activities such as working in a science lab (54%), completing a bachelor’s degree in science (62%), and enrolling in a Ph.D. program in science, mathematics and engineering. Lower numbers of students responded that they were now more likely to enroll in medical school (20%), or enroll in a program for a different professional degree (16%).

Students in the BIO-REU program were more likely to say they would work in a science lab than students in other programs. They also expressed a higher likelihood of entering medical school than did students in other types of undergraduate research programs.

Concluding remarks

Overall, the findings indicate that the majority of BIO REU students in summer 2010 made significant gains in domains important to their personal and professional growth as young scientists. In general, the gains observed are consistent with the gains previously observed for exemplary undergraduate research programs (Laursen et al., 2010). Patterns of greater gains reported by certain demographic groups are quite interesting, and largely consistent with some prior findings on the outcomes of undergraduate research for first-generation college students and members of minority groups underrepresented in the sciences (see Chapter 2 of Laursen et al., 2010). Since the sample sizes are small for some of these demographic subgroups, it is important to know if these patterns are reproduced or expanded to other groups in the future.

The data presented in this document provide a snapshot of the possible gains that result from summer REU programs in biology, as only one third of the funded BIO REU sites participated in the 2010 pilot. We hope that they provide useful information to site PIs.

Participation by all of the funded sites will enrich this baseline data set making it more representative of all of the different types of sites funded by the Bio REU Program. Examples of interesting research questions that could potentially be examined with a more comprehensive set of data include:

- Are the differences in gains observed for different demographic groups and institutional types maintained in future years?
- How might sites alter their recruitment and UR teaching strategies in order to recruit students who have the most potential for gains?

Implementation of the BIO REU URSSA does not preclude funded sites from using their own assessment instruments. Indeed, we suggest that BIO REU Sites should use other types of assessment techniques in order to complement and help to interpret the information that the BIO REU URSSA can provide.

Contributions and Acknowledgments

Tim Weston revised and administered the survey, aggregated and analyzed the data, and drafted the report. As co-chairs of the Biology REU Leadership Council Assessment Committee, Janet Branchaw and Julio Soto coordinated the implementation of the survey within the PI community, provided a PI perspective to the study design, and reviewed and edited the report. Sandra Laursen assisted in the study design and served as a consultant to the team, a reviewer of the report and a connection to the other URSSA REU projects. We are grateful to all the students and site PIs who participated in this pilot study.

For more information about URSSA and its development, please visit <http://www.colorado.edu/eeer/research/undergradfaqs.html>

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Appendix: Supplementary Tables

Table A.1 Mean Gains Scores for Individual Items: 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)	Student group	
	BIO REU	Other UR Programs
	Mean	Mean
Analyzing data for patterns.	4.00	3.87
Figuring out the next step in a research project.	4.16	4.13
Problem-solving in general.	4.19	4.06
Formulating a research question that could be answered with data.	3.95	3.82
Identifying limitations of research methods and designs.	4.21	4.25
Understanding the theory and concepts guiding my research project.	4.43	4.31
Understanding the connections among scientific disciplines.	4.05	4.18
Understanding the relevance of research to my coursework.	4.10	3.91
Understanding the importance of ethics and the responsible conduct of research.	4.18	.
Understanding how data are collected.	4.31	.

Table A.2 Mean Gains Scores for Individual Items: 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)	Student group	
	BIO REU	Other UR Programs
	Mean	Mean
Confidence in my ability to contribute to science.	4.21	4.03
Comfort in discussing scientific concepts with others.	4.25	4.06
Comfort in working collaboratively with others.	4.21	4.11
Confidence in my ability to do well in future science courses.	4.29	3.96
Ability to work independently.	4.31	4.20
Developing patience with the slow pace of research.	4.07	4.05
Understanding what everyday research work is like.	4.48	4.45
Taking greater care in conducting procedures in the lab or field.	4.30	4.20

Table A.3 Mean Gains Scores for Individual Items: 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)	Student group	
	BIO REU	Other UR Programs
	Mean	Mean
Writing scientific reports or papers.	3.78	3.44
Making oral presentations.	4.10	4.02
Defending an argument when asked questions.	3.77	3.62
Explaining my project to people outside my field.	4.24	4.15
Preparing a scientific poster.	4.11	3.94
Keeping a detailed lab notebook.	3.96	3.72
Conducting observations in the lab or field.	4.06	3.89
Using statistics to analyze data.	3.52	3.13
Calibrating instruments needed for measurement.	3.41	3.42
Working with computers.	3.40	3.48
Understanding journal articles.	3.94	3.81
Conducting database or internet searches.	3.69	3.58
Managing my time.	3.87	3.59

Table A.4 Mean Gains Scores for Individual Items: Scientific Attitudes and Behaviors

During your research experience HOW MUCH did you: (Five point scale: None – a great deal)	Student group	
	BIO REU	Other UR Programs
	Mean	Mean
Engage in real-world science research	4.59	4.48
Feel like a scientist.	4.41	4.31
Think creatively about the project.	4.22	4.05
Try out new ideas or procedures on your own.	3.67	3.73
Feel responsible for the project.	4.45	4.32
Work extra hours because you were excited about the research.	4.03	3.81
Interact with scientists from outside your school.	3.95	3.90
Feel a part of a scientific community.	4.33	4.19