

BIO REU Interim Report

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Executive Summary

Two-hundred and –thirty-two (232) students at 28 sites and 23 institutions took the Undergraduate Research Student Self Assessment (URSSA) during Summer 2010.

Students participating in the BIO-REU program 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.

Core areas of the URSSA include *Thinking and Working Like a Scientist*, *Personal Gains*, *Skills* and *Scientific Attitudes and Behaviors*. We averaged ratings across questions in and compared with all other students from other programs taking the survey.

The comparison showed higher overall ratings for students in the BIO-REU program for *Personal Gains* and *Scientific Attitudes and Behaviors*.

Examination of averages for each BIO-REU suggests that students at most sites give similar (and very high ratings), although at some sites students at several sites collectively gave much lower ratings.

Demographic analysis of the composite variables showed:

- Students at private institutions reported gaining more than 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 HS 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 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* (4.3) significantly higher than other programs.
- BIO-REU students primarily learned about the REU from announcements (63%), the NSF website (60%) and academic advisors (60%).
- BIO-REU students said 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 and engineering after they had completed their REU.

Students answering open-ended questions reported:

- Networking and interacting with mentors and peers was seen as an important benefit of attending the REU by 25% of the students.
- Thirty percent of students said doing hands-on scientific work was the most valuable part of the REU experience.
- Twenty-one percent of students said their REU experience confirmed or strengthened an existing decision to attend graduate school.
- Twenty percent said they changed their mind about their future plans during the REU and wanted to attend graduate school.
- Twenty percent wanted more time with their mentors and their mentors more involved in the students' research.

This report presents the results of the *Undergraduate Research Student Self Assessment* (URSSA) for Summer 2010. Summarized are average scores on survey items, comparisons with other programs, and analysis of demographic differences among students taking the survey. This year's results also acts as a baseline for future administrations of the survey. 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 which research activities they participated in, how they learned about the program, and if the program changed future educational or vocational plans.

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, the core group of questions is “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 Summer 2010 Administration

Two-hundred and –thirty-two (232) students at 28 sites and 23 institutions took URSSA during Summer 2010. The URSSA survey contains 17 sections; tables and figures present the means and frequencies for the BIO-REU program compared with those from 799 students from 45 institutions in all other programs using the survey.¹

Students participating in the BIO-REU program primarily (83%) came from public institutions; table 1 presents the number of institutions and the number of students from each site that completed the survey. Students came primarily from upper classes (64% Junior and Senior), were diverse with 46% White, 26% African American and 17% Hispanic, and majority female (61%).

¹ Actual numbers of students answering each item vary, especially for items in the second half of the survey.

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

Table 1 Institutions completing URSSA

	TYPE OF INSTITUTION	
	PRIVATE	PUBLIC
ALASKA STATE		8
CAREY INSTITUTE	12	
COLORADO STATE UNIVERSITY		9
INDIANA STATE		13
JOHNS HOPKINS	14	
MARQUETTE	12	
NORTH CAROLINA STATE		11
OHIO STATE		9
		16
PRINCETON	4	
SAM HOUSTON STATE		7
SAN DIEGO STATE		6
SAN FRANCISCO STATE		7
SAN JOSE STATE		10
UC DAVIS		4
UNIVERSITY OF MINNESOTA		9
UNIVERSITY OF WASHINGTON		10
UNIVERSITY OF ARKANSAS		2
UNIVERSITY OF CONNECTICUT		10
UNIVERSITY OF MASSACHUSETTS		10
UNIVERSITY OF NEBRASKA		7
UNIVERSITY OF NORTH CAROLINA		10
UNIVERSITY OF S. ALABAMA		11
UNIVERSITY OF WISCONSIN		14
		5

Table 2 Demographics

		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%
What is your gender?	Male	89	38.5%
	Female	142	61.5%
GPA (on a 4-point scale)	below 2.0	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%

Figure 1 Class Standing

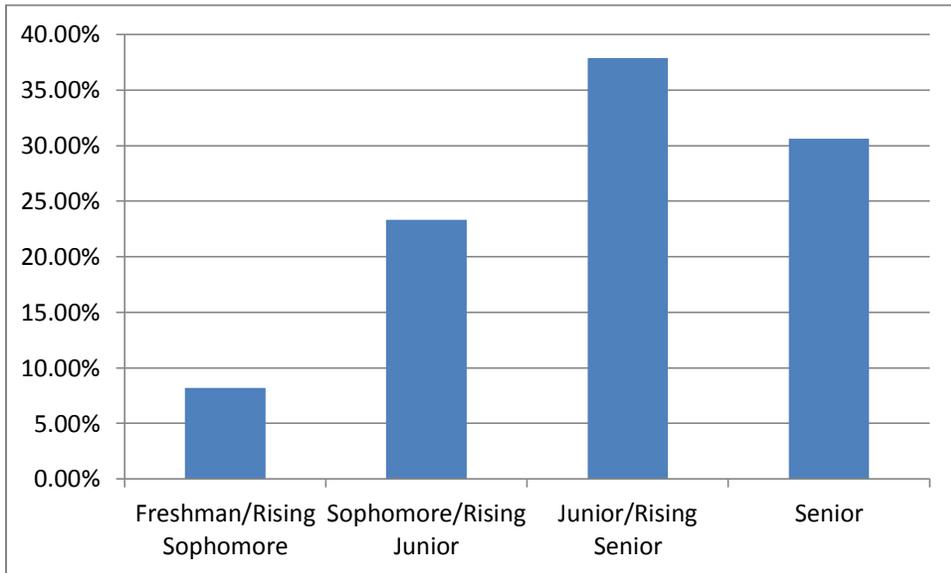


Figure 2 Race/Ethnicity

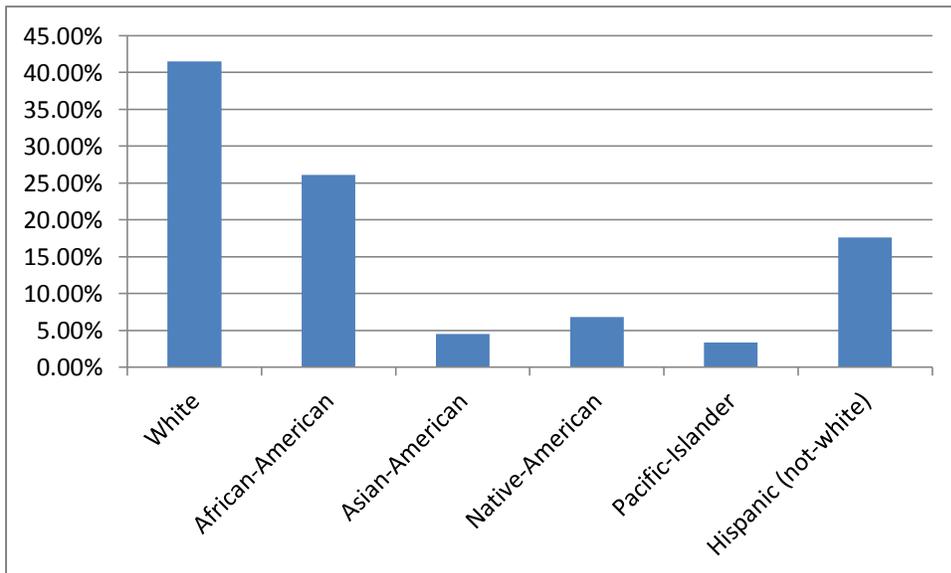


Figure 3 Gender

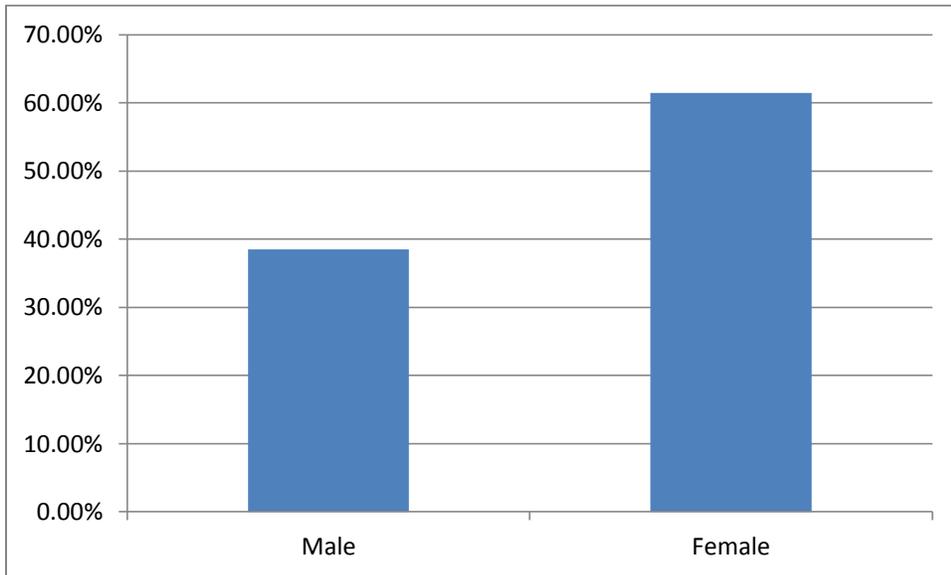


Figure 4 GPA

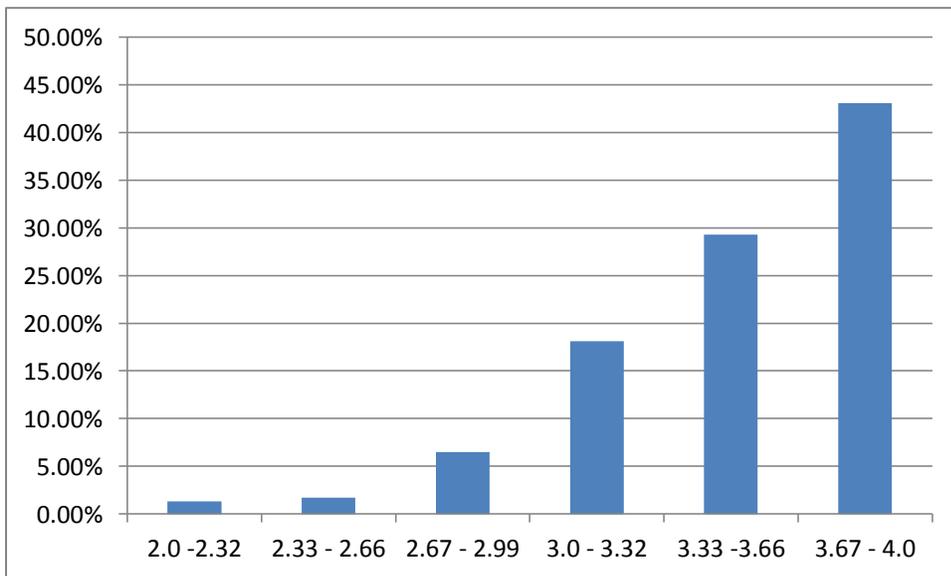


Table 3 Frequency of participation in REU's

		PROGRAM	
		BIO REU	Other Programs
		Column N %	Column N %
How many times have you participated in ACADEMIC YEAR research?	Never	40.5%	45.0%
	1 semester	17.6%	18.5%
	2	22.9%	14.8%
	3	10.6%	7.4%
	4 or more semesters	8.4%	14.3%
How many times have you participated in SUMMER research?	Never	34.4%	42.6%
	1 semester	35.2%	24.4%
	2	23.8%	19.3%
	3	6.6%	7.6%
	4 or more semesters	.0%	6.1%

Figure 5 How many times have you participated in academic year research?

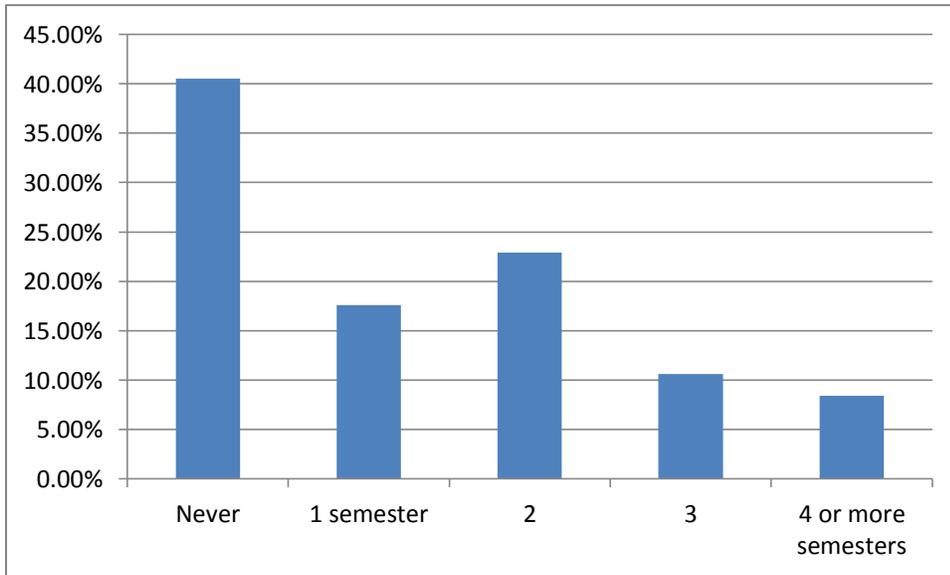
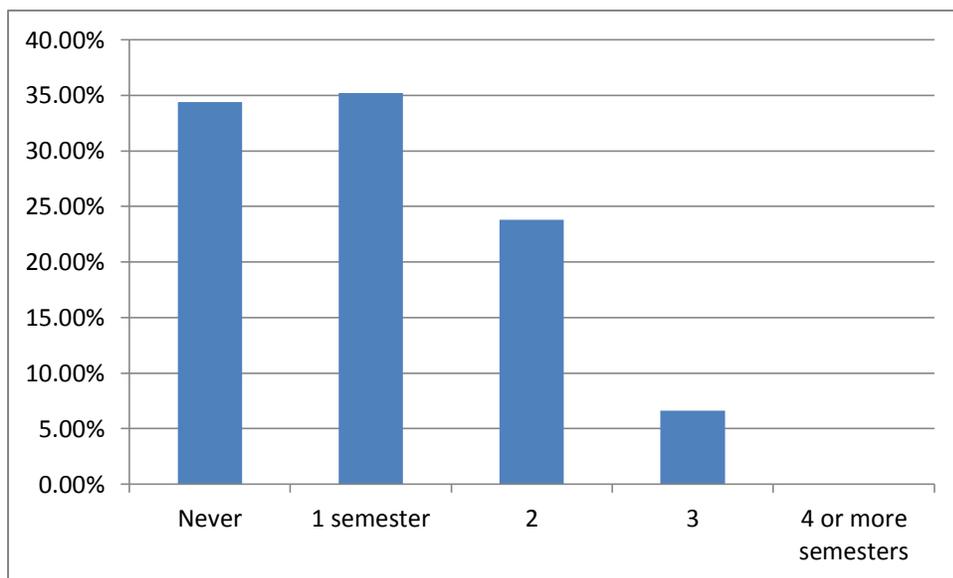


Figure 6 How many times have you participated in summer research?



1.2 Core Items: Comparisons with other 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 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. 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 4 shows the comparison between BIO-REU and students in other programs. Scores on the scales for *Personal Gains* and *Attitudes and Behaviors* are significantly higher for students in the BIO-REU program.

Table 4 Composite Variables

		BIO REU	Other Programs
THINKING & WORKING LIKE A SCIENTIST (ADJ MEAN)	Mean	4.02	3.91
	SD	1.00	1
	N	231	782
PERSONAL GAINS (ADJ MEAN)	Mean	4.29*	4.11
	SD	1.01	.97
	N	238	799
SKILLS (ADJ MEAN)	Mean	3.87	3.77
	SD	1.00	1
	N	176	785
ATTITUDES & BEHAVIORS (ADJ MEAN)	Mean	4.21**	3.86
	SD	1.02	1.02
	N	235	739

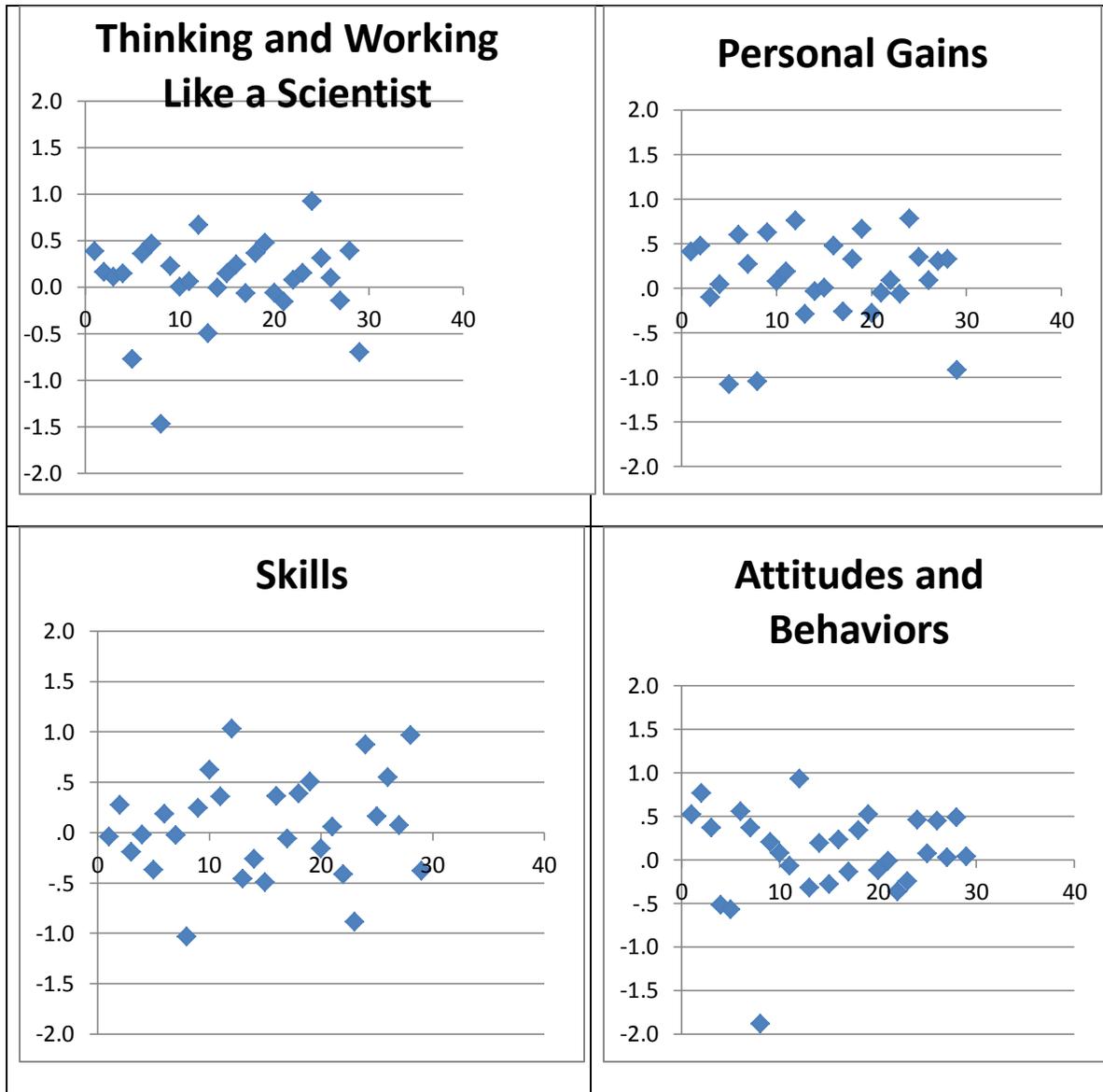
*Difference significant at $p < .05$, ** $p < .01$. Differences adjusted for demographic differences between groups.

1.3 Core Items: Comparisons across sites

Averages on the core variables were also calculated for each site. Figure 7 shows the dispersion of averages on these variables; specific sites are not identified by name. A standardized metric was used to plot the means; 0 is the average for all schools, each unit is a standard deviation away from the mean.

Examination of the figures suggests that students at most sites give similar ratings, although at some sites, especially for the *Personal Gains* score, students at several sites collectively gave much lower ratings. Overall, the site where a student participated in their REU explained only 10% of the variability in their ratings.

Figure 7 Dispersion of ratings for REU sites



1.4 Core Items: Demographic differences

Information about students included *Gender, Class Standing, Race/Ethnicity, GPA* and *Parental Education* and if they attended a public or private institution. The table summarizes demographic differences for the core items found to be statistically significant (individual tables are found in the appendix). Some of the differences may seem surprising, these included 1) students at private institutions reported gaining more than 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 HS reported gaining more than students whose parents held advanced degrees. Gender and GPA did not correlate with gains for these items.

Table 5 Demographic differences for students taking URSSA

	Institution Type	Gender	Class Standing	Race/Ethnicity	GPA	Parental Education
Thinking & Working Like a Scientist	.21 Private – Public	--	-.--	.56 AfrAm – White	---	.67
Personal Gains	.28 Private – Public	--	.40 Sophomore – Senior	.55 AfrAm – White	.22 High - low	.54 No HS – Ph.D
Skills	--	.15 female - male	.43 Freshman – Senior	.65 AfrAm – White	---	.63 No HS – Ph.D
Attitudes & Behaviors	.57 Private - Public	--	.42 Freshman – Senior	.37 AfrAm – White	---	.39 No HS – Ph.D

2.1 Optional Sections for URSSA

2.1.1 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, 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 programs, and planned to present and attend conferences at greater rates than students in other programs.

Table 6 Research experience

As part of my most recent research experience... Research Experience (0, 1 Proportion “Yes”)	PROGRAM	
	BIO REU	Other Programs
	Proportion	Proportion
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

2.1.2 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. 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 programs found that students in the BIO-REU program rated *the amount of time I spent doing meaningful research* (4.35) and *the amount of time I spent with my research mentor* (4.3) significantly higher than other programs. Students also rated activities such as support and guidance about research projects higher, as well as the financial support given by the program. For the general satisfaction item *rate your research experience overall* most sites averaged between ratings of 4 and 5.

Figure 8 Satisfaction with program by site

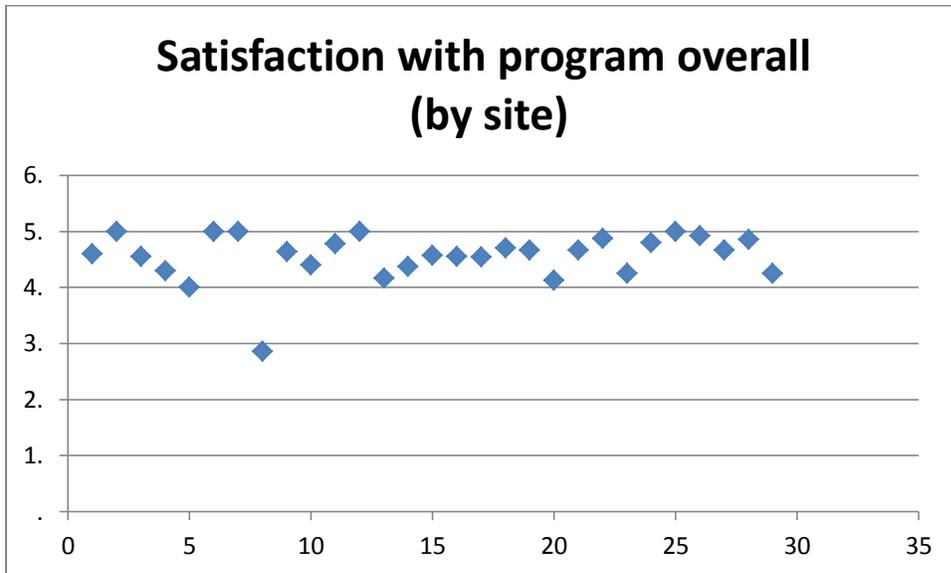


Table 7 Satisfaction ratings

Ratings (2 - 5, Poor, Fair, Good, Excellent)	PROGRAM	
	BIO REU	Other 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	.

Table 8 Satisfaction with program

How satisfied were you with: (2 - 5, Very dissatisfied – Very satisfied)	PROGRAM	
	BIO REU	Other 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 9 Preparation for education and other future endeavors

Agree/Disagree (2 – 5, Strongly Disagree – Strongly Agree)	PROGRAM	
	BIO REU	Other 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	.

2.1.4 Source of information about the program and reasons for attending

Students were asked where they learned about their REU. The most common places were from announcements (63%), the NSF website (60%) and academic advisors (60%). Less common sources were presentations given by professors (19%) and web searches (25%).

A large majority of students chose many of the 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%). Fewer students were drawn to programs because of specific professors (48%).

Table 10 Source of information about REU

I found out about the REU from: (Proportion “Yes”)	PROGRAM	
	BIO REU	Other Programs
	Proportion	Proportion
From a professor or other students	.50	.47
The NSF web site	.60	.51
A poster or flier	.13	.09
In class	.29	.
An academic advisor	.60	.
An announcement (flyer, poster, email, website, etc.)	.63	.
A presentation given by professors or students about their research	.19	.
Web search	.25	.

Table 11 Reason for doing research

I wanted to do research to: (Proportion “Yes)	PROGRAM	
	BIO REU	Other programs
...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 resume	91%	92%

2.1.5 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*.²

Higher percentages are seen for the *much more/extremely more likely* 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 more likely to enroll in medical school (20%), or enroll in a program for a different professional degree (16%).

Student 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 more likelihood of entering medical school than the other students.

² This part of the survey needs revision; examination of open-ended responses suggests that many students had already made a decision before starting the REU, and answers reflect plans they had already made beforehand.

Table 12 Likelihood of intentions (% of students)

Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:			
		BIO-REU	Other Programs
...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

2.1.6 Hours per week engaged in activities

Students were asked to report how many hours they spent talking per week with their research mentor. Forty-five percent reported spending 4 or more hours. Less time was spent working with senior research members (2 hours was the most frequent response); 62% of students reported working 4 or more hours with other undergraduates.

Table 13 Frequency of activities

		BIO REU	
		Count	Column N %
		On average, how many hours per week did you spend talking with your most recent research mentor?	None
	1 hour	32	18.6%
	2 hours	38	22.1%
	3 hours	17	9.9%
	4 or more	78	45.3%
How many hours did you spend with:		Count	Column N %
... the person who served as your main research advisor	None	0	.0%
	1 hour	4	25.0%
	2 hours	0	.0%
	3 hours	2	12.5%
	4 hours or more	10	62.5%
...the faculty member or senior researcher in your lab	None	2	12.5%
	1 hour	6	37.5%
	2 hours	4	25.0%
	3 hours	0	.0%
	4 hours or more	4	25.0%
other postdocs and grad students	None	0	.0%
	1 hour	4	25.0%
	2 hours	2	12.5%
	3 hours	0	.0%
	4 hours or more	10	62.5%
other undergraduates	None	6	37.5%
	1 hour	0	.0%
	2 hours	2	12.5%
	3 hours	0	.0%
	4 hours or more	8	50.0%

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, 2) how the research influenced their future work and graduate school plans, 3) the strengths of their program, and 4) how the program could be improved. Categories of student responses are found in the tables below (tables 14 -18).

One-hundred-twenty or 51% of (120) 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 (25%) included networking with peers, mentors and graduate students. Students also reported learning specific skills such as lab techniques, data analysis, and personal skills such as time management. Other areas mentioned were increased confidence in students' ability to do science, familiarization with authentic scientific activities, and clarification of plans for the future.

Two-hundred-eighteen or 90% of 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 said their experience confirmed or strengthened an existing decision to attend graduate school. Twenty percent said they changed their mind during the REU and wanted to attend graduate school. Another 20% 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. Ten percent said they changed their mind during the REU and wanted a career in science, either as a researcher or technician; another 10% said the REU experience had changed their mind about becoming a scientist or attending graduate school in science.

Forty-three (18%) students answered the question: *What has been the best part of the REU experience?* Thirty percent of students answering the question said doing hands-on scientific work was the most valuable part of the experience; 21% cited specific skills gained during experience such as conducting literature reviews, presentations, and creating posters. Other students felt interactions with mentors, socializing or gaining information about science were the best parts of the experience.

Two questions asked students how they would improve their REU experience: *What would have made your research experience better?* (139, 58%) and *What would improve the undergraduate research program, overall?* (141, 59%). Twenty percent answering the first question wanted more time with their mentors and their mentors more involved in the students' research. Other concerns included:

- *Scheduling*: not having enough time during the summer session to complete projects
- *Logistics*: concerns with housing or transportation.
- *Organization*: Lack of organization with lab activities, guidance in getting started, "dead time" during the daily schedule.
- *Social*: Students wanted more organized social activities and chances to network with other students, graduate students and researchers.

Table 14: *Did you make other gains from doing research that we didn't mention? If so, please briefly describe these.*

	N	%	Example
Networking, meeting new people	30	25.0	<i>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.</i>
Specific skills	28	23.3	<i>I became much more familiar with lab techniques and actually applying what I learned in class to what I used in the labs.</i>
Increased confidence	20	16.7	<i>I feel a lot more confident in my ability to conduct independent scientific research.</i>
Learned about practical aspects of science	14	11.7	<i>i gained some insight into the daily tasks of a researcher</i>
Clarified Plans for the Future	11	9.2	<i>I realized that if I do choose to pursue a PhD, then I would like to pursue it in the field of cancer biology.</i>
General positive comments	7	5.8	<i>Met wonderful people and became involved in amazing projects I expect to continue doing and collaborating with!</i>
Learned about how science works	4	3.3	<i>I learned that biophysics is very similar to chemistry, and that I like it even more!</i>
General negative comments	4	3.3	<i>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.</i>
Learned importance of mentor	1	.8	<i>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.</i>

Table 15: *How did your research experience influence your thinking about future career and graduate school plans? Please explain.*

	N	%	Example
Confirmed existing plans for going to graduate school	46	21.1	<i>It confirmed that I want to continue on to graduate school.</i>
Changed mind and will attend graduate school	45	20.6	<i>My research influenced me to want to pursue a PhD and get a career doing research.</i>
Provided better information about graduate school so can make a more informed decision	44	20.2	<i>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.</i>
Changed mind about vocation, will get a job in science	22	10.1	<i>It made me realize that a career in science is definitely what I wish to pursue.</i>
No change in plans	22	10.1	<i>Not much. Plans remain to attend Graduate school.</i>
Changed mind about going to graduate school, will not go	20	9.2	<i>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.</i>
Gave me confidence to know I can go to graduate school	10	4.6	<i>It made me much more excited for the opportunities I have in the future.</i>
Will go to medical school	2	.9	
Off topic	7	3.2	
Total	218	100.0	

Table 16: What has been the best part of the REU experience?

	N	%	Example
Hands-on experiences	13	30.2	<i>I learned so much more doing research than I usually do in classes because I was constantly surrounded by it and it was always changing. I was usually engaged and interested because it was a process.</i>
Skills gained	9	20.9	<i>I think that writing the literature reviews was extremely helpful. I had never written one before and I found it a great experience.</i>
Experiences with mentors	7	16.3	<i>The relationship with my mentor was great. I learned so much.</i>
People, networking	6	14.0	<i>Interacting with the other researchers in my lab.</i>
General positive comments	5	11.6	<i>My lab was phenomenal! Great support group and easy to work with.</i>
Information gained	3	7.0	<i>All the information that I learned!</i>
Total	43	100.0	

Table 17: *What would have made your research experience better?*

Category	N	%	Example
Nothing needed to change, good as it was	42	30.2	
Wanted mentor more involved in work, more accessible, more time with mentor	24	17.3	<i>If my mentor was more enthusiastic and excited about the research I was doing. If she was available to answer my questions</i>
Wanted to do different activities or learn different skills	18	12.9	<i>Maybe more presentations on our research throughout the summer versus only having the big presentation at the end.</i>
Scheduling; not enough time to complete work	17	12.2	<i>Having more time to think and learn. Less rushing for results. We would have gone further if we had not rushed everything.</i>
Lab disorganized, needed activities better organized	15	10.8	<i>Maybe more organization. I was never really sure when I had to be certain places or do certain places with the other REU students.</i>
Logistical problems	9	6.5	<i>Having a car, or some reliable means of transportation.</i>
Relationships with peers	7	5.0	<i>More motivated and excited participants...in some cases.</i>
Needed more information about program	5	3.6	<i>Needed a session on graduate school programs.</i>
Insufficient resources	2	1.4	<i>Having more instruments to work with...like a PCR machine for example.</i>
Total	139	100.0	

Table 18: *What would improve the undergraduate research program, overall?*

	N	%	Example
Specific activities	26	18.2	<i>More workshops on scientific writing, statistics, etc.</i>
More information	6	4.2	<i>More information about graduate school.</i>
Better logistics	9	6.3	<i>No cable in the rooms kind of drove me stir crazy... sometimes you need to be able to escape and not think about the labs for a moment so that you can return to your work refreshed and able to look at problems in a different light.</i>
Mentor	10	7.0	<i>More excitement and interest from the program coordinators.</i>
No changes	38	26.6	
Better organization	15	10.5	<i>a little more organized activities for the REU students...</i>
More social activities	19	13.0	<i>More social activities with fellow program members would have enhanced the overall experience.</i>
Scheduling	19	13.0	<i>If I had a bit more time to gather data, I suspect that I as well as others could build more conclusive results.</i>
Total	143	100.0	100.0

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	Other 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 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	Other 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 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)	PROGRAM	
	BIO REU	Other 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 1.4 Attitudes and Behaviors

During your research experience HOW MUCH did you: (Five point scale: None – a great deal)	PROGRAM	
	BIO REU	Other 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

Table 1.5 Class standing and averages for composite variables

		Class Standing				
		Freshman /Rising Sophomore	Sophomore /Rising Junior	Junior /Rising Senior	Senior	Other
THINKING & WORKING LIKE A SCIENTIST (ADJ MEAN)	Mean	4.05	4.01	4.05	3.92	4.45
	SD	1.21	.85	.92	1.23	.52
	N	16	59	90	59	7
PERSONAL GAINS (ADJ MEAN)	Mean	4.39	4.44	4.30	4.07	4.92
	SD	1.16	.80	.89	1.28	.29
	N	17	59	94	63	5
SKILLS (ADJ MEAN)	Mean	4.13	3.92	3.87	3.70	4.63
	SD	1.09	.93	.92	1.14	.50
	N	14	45	62	52	3
ATTITUDES & BEHAVIORS (ADJ MEAN)	Mean	4.46	4.28	4.21	4.04	4.49
	SD	.69	.84	1.06	1.17	.45
	N	19	59	88	62	7

Table 1.6 Gender and averages for composite variables

		GENDER	
		Male	Female
THINKING & WORKING LIKE A SCIENTIST (ADJ MEAN)	Mean	4.04	4.01
	SD	.95	1.04
	N	91	139
PERSONAL GAINS (ADJ MEAN)	Mean	4.28	4.31
	SD	1.03	1.00
	N	94	143
SKILLS (ADJ MEAN)	Mean	3.78	3.93
	SD	1.01	1.00
	N	75	101
ATTITUDES & BEHAVIORS (ADJ MEAN)	Mean	4.17	4.23
	SD	.98	1.03
	N	90	144

Table 1.7 GPA and averages for composite variables

GPA		2.67 - 2.99	3.0 - 3.32	3.33 -3.66	3.67 - 4.0
THINKING & WORKING LIKE A SCIENTIST (ADJ MEAN)	Mean	3.77	4.10	3.92	4.03
	SD	1.29	1.06	.96	1.02
	N	14	39	61	94
PERSONAL GAINS (ADJ MEAN)	Mean	4.09	4.35	4.23	4.31
	SD	1.24	.98	1.01	1.03
	N	15	42	64	96
SKILLS (ADJ MEAN)	Mean	3.81	3.98	3.86	3.85
	SD	1.12	1.03	1.04	.98
	N	13	35	35	74
ATTITUDES & BEHAVIORS (ADJ MEAN)	Mean	4.21	4.31	4.10	4.25
	SD	.69	1.04	.88	1.16
	N	15	40	64	95

Table 1.8 Race/Ethnicity and averages for composite variables

		RACE ETHNICITY				
		WHITE	AFRICAN-AMERICAN	ASIAN-AMERICAN	NATIVE AMERICAN	HISPANIC (NON-WHITE)
THINKING & WORKING LIKE A SCIENTIST (ADJ MEAN)	Mean	3.78	4.34	4.13	4.31	4.15
	SD	1.04	.58	.97	.98	.87
	N	83	43	8	11	28
PERSONAL GAINS (ADJ MEAN)	Mean	4.11	4.69	4.61	4.28	4.43
	SD	.99	.63	.59	1.31	.89
	N	85	47	8	12	29
SKILLS (ADJ MEAN)	Mean	3.64	4.29	4.00	3.97	3.83
	SD	.97	.71	1.43	1.19	.90
	N	60	33	6	12	22
ATTITUDES & BEHAVIORS (ADJ MEAN)	Mean	4.05	4.42	4.23	4.23	4.14
	SD	1.05	.79	1.47	.96	1.09
	N	85	42	8	12	28

Table 1. 9 Father's Education and averages for composite variables

		Father's Education				
		Not a high school grad	High school grad	Some college	college grad	Advanced degree
THINKING & WORKING LIKE A SCIENTIST (ADJ MEAN)	Mean	4.48	4.02	4.01	4.06	3.81
	Standard Deviation	.73	1.16	.93	.99	1.04
	Valid N	19	48	40	56	52
PERSONAL GAINS (ADJ MEAN)	Mean	4.63	4.19	4.35	4.39	4.09
	Standard Deviation	.70	1.18	.91	.94	1.10
	Valid N	22	50	41	57	52
SKILLS (ADJ MEAN)	Mean	4.28	3.83	3.92	4.06	3.65
	Standard Deviation	.98	1.13	.83	.97	1.02
	Valid N	14	40	28	44	36
ATTITUDES & BEHAVIORS (ADJ MEAN)	Mean	4.53	4.14	4.27	4.27	4.14
	Standard Deviation	.82	1.20	.75	1.09	1.02
	Valid N	20	49	42	58	52