The SURE Survey: Descriptive Statistics and Commentary

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Introduction

It is commonly observed that a feature of an authentic undergraduate research experience is that the knowledge to be harvested from the research is ostensibly unknown to everyone – the undergraduate student, the graduate student, the post doc, the professor, the professional researcher, the community. Fortenberry (1998)[1], pointing out the difference between research and inquiry-based learning, suggested that "the only fundamental difference between research and inquiry-based learning is the prior state of knowledge of the broader community. In research it is unknown by all; in inquiry it is only unknown by the learner." The inquiry-based side of this distinction acknowledges the authority of the course instructor or laboratory mentor. We, the experts, can take advantage of our knowledge to design laboratory or inquiry exercises that require the undergraduate student to reconstruct significant knowledge in our disciplines. We know something the student does not know. For authentic research, we and the undergraduate researchers inhabit a more egalitarian space. We have the expertise to guide the student researcher, but we cannot know the outcome before it ripens.

There is another sense in which the mentor does not know the outcome of the undergraduate research experience until it matures, and that is that we don't know in advance if the experience yields for the student the goals of professional and personal development for which the experience is supposed to set the occasion. But the attainment of these outcomes is not unknown by all; the degree to which the goals have been attained is known to the student. From the point of student engagement with the discipline, from student morale, and from an inclination to continue a career in the discipline, the student knows more than the mentor. The table of authority has been turned; the student knows something we don't. The evaluation of the research program that led to this outcome now becomes an exercise in inquiry-based learning for the institution. The students articulate their outcomes, and we then engage in an exercise in constructive learning to understand how the outcomes were attained.

Once we accept that student success is the driver of undergraduate research programs, it becomes clear that students need to be invited to disclose the effects a program has on their behavior and attitudes. The challenge is how best to make this invitation. The interesting outcomes of undergraduate research, so personal to the student, force us to depart from the hoary distinction between "direct measures" (e.g., tests on the content of a discipline) and "indirect measures" (self-report). In assessment literature, self-report is often marginalized as a kind of end-of-course evaluation, in which students comment on the success of a classroom instructor.

[1] Fortenberry, N.L. (1998). Integration of research and curriculum. Council on Undergraduate Research Quarterly, 19, 54-61.

In undergraduate research, however, what we desire to know is not self-report but self-disclosure. The student needs to reveal their plans to continue or not continue in the field; their gains in self-confidence and engagement with work; their attitude toward the discipline. The success of a research program depends on this information. Consider, for example, that most undergraduate research programs in STEM (Science, Technology, Engineering, and Mathematics) claim to contribute potential human resources to these fields via engaging undergraduates in authentic research experiences. These experiences encourage students to plan to go into the field and to feel that they will be successful if they do. Notice, as well, that the claim is transdisciplinary, carrying the same weight for biology as for chemistry, engineering, and mathematics.

The SURE (Survey of Undergraduate Research Experiences) was a project that resulted from a collaboration with Professor Sarah C. R. Elgin, then affiliated with Washington University in St. Louis, and supported by the Howard Hughes Medical Institute. The survey has gone through several revisions, hence its current title as SURE III. The survey project led to the creation of a pre-experience student survey (Preflection) and a follow-up survey. The initial research was reported in Lopatto (2004)[2] and a second major report was published in 2007[3]. Requests for a version of SURE that may be employed for course-embedded research experiences led to the creation of the CURE survey, which shares some items with the SURE. The statistics in this report are from the SURE III comprising the years 2011 to 2018. The total number of respondents is 24,907 although there are missing values whenever a student chose "N.A." and declined to provide a response.

Survey results

Background statistics

Gender categories: Female – 14,250 (60.9%), Male – 9,156 (39.1%)

It is not atypical for student surveys to be answered by more self-identified women than men. Students uncomfortable with the gender binary had the option of not responding.

[2] Lopatto, D. (2004). Survey of Undergraduate Research Experiences (SURE): First Findings. Cell Biology Education, 3, 270-277.

[3] Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. CBE – Life Sciences Education, 6, 297-306.

Table 1. **Ethnic categories**

	Frequency	Percent
Alaskan Native	7	0.0
American Indian	157	0.7
Asian American	2680	11.7
Black or African American	1800	7.9
Filipino	155	0.7
Foreign National	726	3.2
Hawaiian	9	0.0
Hispanic/Latino	2205	9.6
Pacific Islander	37	0.2
White	13156	57.5
Two or more races	1288	5.6
Other	649	2.8

Table 2. **Current status/rank**

	Frequency	Percent
High School	934	4.0
First-year college student	1254	5.4
Second-year college student	3980	17.0
Third-year college student	7233	30.9
Fourth-year college student	8920	38.2
Graduate or medical student	586	2.5
Other	471	2.0

Table 3. **Academic Major**

	Frequency	Percent	% Women	% UR
Biology	7673	33.0	67.8	22.1
Chemistry	3030	13.0	58.3	16.4
Physics	1497	6.4	37.8	11.4
Earth and Planetary Sciences	504	2.2	66.9	8.3
Mathematics	976	4.2	51.4	14.8
Computer Science	795	3.4	37.8	15.7
Biochemistry	2383	10.3	58.9	18.1
Bioinformatics	98	0.4	52.6	17.4
Psychology	905	3.9	81.2	19.3
Neurobiology	1224	5.3	70.8	17.2
Engineering	1897	8.2	42.6	23.1
Education	78	0.3	81.3	17.6
Other: Social Science	403	1.7	67.9	20.5
Other: Humanities	310	1.3	68.9	15.2
Other: Natural Science	503	2.2	75.1	19.0
Other	638	2.7	73.8	24.7
Undecided	334	1.4	66.0	21.1

The original support for the SURE was an HHMI grant, which may explain why the survey became popular in the biological sciences more than in other disciplines. Because about 61% of the respondents identified as women, it might be expected that women would constitute a higher percentage of the respondents in each major. It is noteworthy that in three majors (Physics, Computer Science, and Engineering) women were in the minority for this data set (% Women). The % UR group comprises the NSF description of underrepresented groups in science, including African-American, American Indian, Native Alaskan, Hispanic, and Native Pacific Islanders. A related question on the SURE has the student respondent identify the research area of their project. The results (not shown) are similar to those in Table 3.

Table 4. **Prior Experience**

	Frequency	Percent
None	10015	42.7
One Academic Semester	2734	11.7
Multiple Semesters	2878	12.3
Summer	2308	9.8
Academic Semester and Summer	2465	10.5
Several Experiences	3037	13.0

One function of an undergraduate research program is to introduce research to inexperienced students. These inexperienced students are most frequent responders to the SURE survey. From 2011 to 2018 there was no trend toward more or fewer inexperienced students completing the SURE.

Table 5. **Continuing educational plans immediately following graduation**

	Frequency	Percent
Ph.D. in biology field	4077	17.8
Ph.D. in physical sciences	3568	15.6
MA in life sciences	846	3.7
MA in physical sciences	1347	5.9
MA or Ph.D. not in science	707	3.1
Medical degree	3847	16.8
M.D./Ph.D.	2760	12.1
Other health professions	1276	5.6
Professional degree such as law	297	1.3
Teaching certificate	250	1.1
Peace Corps or similar	349	1.5
Work first then school	2591	11.3
Science career with no additional school	769	3.4
Nonscience career with no additional school	201	0.9

This question was limited to educational plans immediately after graduation. Students who had no plans could opt out.

Table 6. **Plans prior to the research experience**

	Frequency	Percent
I had not considered post-undergraduate education	1686	7.5
I planned not to pursue education	1000	4.4
Masters in science field	3708	16.5
Ph.D. in science field	7947	35.3
Masters in nonscience field	606	2.7
Ph.D. in nonscience field	400	1.8
Medical degree	6733	29.9
Law or professional degree	429	1.9

Table 7. **Plans after having the research experience**

	Frequency	Percent
I have not considered post-undergraduate education	631	2.9
I now plan not to pursue education	867	4.0
Now plan Masters in science field	3761	17.2
Now plan Ph.D. in science field	9352	42.7
Now plan Masters in nonscience field	585	2.7
Now plan Ph.D. in nonscience field	481	2.2
Medical degree	5772	26.4
Law or professional degree	449	2.1

The SURE survey poses two related propositions to the student respondent: "Before I started the research project…" followed by eight options (not including N.A.), and "After having the experience of my research project…" followed by eight parallel options (not including N.A.). Asking the student to retrospect about their pre-experience plans may seem unusual, however, there is an intriguing literature (e.g., Howard, et al., 1979)[4] that suggests that respondents make valid comparisons when asked to retrospect the past in comparison to the present. Cross-tabulations of the responses show movement from not considering educational plans to considering educational plans as well as movement from prior consideration of a medical degree to post-experience consideration of a doctoral degree in science (Lopatto, 2004; 2007).

[4] Howard, G.S., et al. (1979). Internal invalidity in pretest posttest self-report evaluations and a re-evaluation of retrospective pretests. Applied Psychological Measurement, 3, 1-23.

Table 8. **Research work environment**

	Frequency	Percent
I work individually	4790	21.3
I work with undergrads have similar, independent projects	7575	33.7
I work with graduate students on similar, independent projects	2345	8.4
I work with undergrads and grads on similar, independent projects	2214	8.7
I work with undergraduates on a single project	3976	20.9
I work with graduates on a single project	784	2.7
I work with both on a single project	1002	4.3

Collaboration is cited as an essential feature of undergraduate research (Auchincloss, et al., 2014)[5]. The closely related term "teamwork" is also cited as a desirable feature of research groups (Miller, et al., 2013)[6]. Research teams come in many flavors; undergraduates may be paired with graduate students or other undergraduate students. The group may follow a division-of-labor approach or stay coordinated. The clearest result that stems from Table 8 is that some students work individually. For students who collaborate with other students, the next task is for them to describe the nature of the relationship, i.e., are they serving as peer mentors.

Table 9. **Your role in the project**

	Frequency	Percent
We are equal partners	11451	81.4
I am a peer mentor	1337	9.5
There is a peer mentor (not me)	1276	9.1

The SURE III survey has a number of items relevant to the student who is a peer mentor, as well as items relevant to the student who worked with a peer mentor. These items will be considered later (Tables 18-23).

[5] Auchincloss, L.C., S.L. Laursen, J.L. Branchaw, K. Eagan, M. Graham, D.I. Hanauer, G. Lawrie, C.M. McLinn, N. Pelaez, S. Rowland, M. Towns, N.M. Trautmann, P. Varma-Nelson, T.J. Weston, and E.L. Dolan. 2014. Assessment of course-based undergraduate research experiences: a meeting report. CBE life sciences education, 13, 29-40.

[6] Miller, C. W., Hamel, J., Holmes, K.D., Helmey-Hartman, W. L., & Lopatto, D. (2013). Extending your research team: Learning benefits when a laboratory partners with a classroom. BioScience, 63, 754-762.

Table 10. **Learning benefits**

Item	Median	Mean	Standard Deviation
Clarification of a career path	3	3.33	1.10
Skill in interpretation of results	4	3.69	0.96
Tolerance for obstacles faced in the research process	4	3.85	0.93
Readiness for more demanding research	4	3.80	0.94
Understanding how knowledge is constructed	4	3.64	0.98
Understanding the research process in your field	4	3.92	0.93
Ability to integrate theory and practice	4	3.62	0.98
Understanding how scientists work on real problems	4	3.84	0.96
Understanding that scientific assertions require supporting evidence	4	3.59	1.14
Ability to analyze data and other information	4	3.72	1.00
Understanding science	4	3.58	1.07
Learning ethical conduct	3	3.28	1.22
Learning laboratory techniques	4	3.80	1.22
Ability to read and understand primary literature	4	3.58	1.12
Skill in how to give an effective oral presentation	4	3.43	1.20
Skill in science writing	3	3.21	1.20
Self-confidence	4	3.49	1.14
Understanding how scientists think	4	3.56	1.05
Learning to work independently	4	3.70	1.10
Becoming part of a learning community	4	3.61	1.11
Confidence in my potential as a teacher	3	3.19	1.25

The lead text for the items in Table 10 asks the respondent to consider a variety of possible of benefits they may have gained from their research experience. The rating scale is 1 (no or very small gain) to 5 (very large gain). The annual data reliably showed that students who chose not to continue in science rated these items lower than other students; that peer mentors rated these items higher than the general population; and that students who had a peer mentor rated these items higher than the general population. The items show strong consistency (Cronbach's α = .95). Results from individual programs vary widely, depending on the emphasis of the program. Some programs neglect writing (skill in science writing), preferring to have the undergraduate researcher engage in data collection or analysis until the end of the program; some programs do not discuss research ethics (learning ethical conduct); many do not discuss the possibility that the student research may be preparing for teaching rather than research (confidence in my potential as a teacher).

Overall experience

Table 11. **How the experience met expectations**

	Frequency	Percent
The experience was worse than I expected.	551	2.4
The experience was a little worse than I expected.	1848	8.0
The experience met my expectations.	6112	26.4
The experience was a little better than I expected.	5974	25.8
The experience was much better than I expected.	8645	37.4

Table 12. **Describe your supervisor**

	Frequency	Percent
College or university professor	14958	64.4
Post-doctoral student	1899	8.2
Graduate student	2592	11.2
Professional researcher or practitioner	3262	14.0
Other	508	2.2

Table 13. **Evaluate supervisor performance**

	Frequency	Percent
I feel that my supervisor was not a good teacher and mentor.	496	2.1
I feel that my supervisor was below average as a teacher and mentor.	722	3.1
I feel that my supervisor was about average as a teacher and mentor.	2622	11.3
I feel that my supervisor was above average as a teacher and mentor.	6658	28.8
I feel that my supervisor was an outstanding teacher and mentor.	12637	54.6

Among the "outstanding" group, professors (56%) and professional researchers (58%) were better represented than graduate students (46%) and postdocs (53%). Respondents were also asked to describe their experience of working with other students. In Table 14 the results are from students who described working in groups (Table 8).

Table 14. **Describe your experience with other students**

	Frequency	Percent
Working with other students was one of the worst parts of the research experience.	265	1.7
Working with other students moderately detracted from my research experience.	936	5.9
Working with other students did not affect my research experience.	1846	11.7
Working with other students moderately enhanced my research experience.	6037	38.2
Working with other students was one of the best parts of the research experience.	6737	42.6

There are many reasons why a group of undergraduate researchers may succeed or fail (e.g., Theobald, et al., 2017)[7]. Table 14 provides information that may alert the program directors or faculty mentors that some dynamic of student group interaction is either enhancing or undermining the success of the undergraduate research experience.

Table 15. **Overall sense of satisfaction from the research experience**

	Frequency	Percent
I am very dissatisfied with this experience	217	0.9
I am mildly dissatisfied with this experience	721	3.1
I feel neutral about the experience	1157	5.0
I am mildly satisfied with this experience	4999	21.5
I am very satisfied with this experience	16155	69.5

It is useful to note the comment on satisfaction by Chambliss and Takacs in "How College Works" (2014)[8]:

> Among assessment experts, "satisfaction" is routinely disparaged as an "indirect measure" of students' gains in college, since it doesn't directly tap the defined academic skills gained. We think, quite to the contrary, that genuine satisfaction might be one of the best measures of all…The satisfaction of former students…is not, then, just another legitimate outcome of going to college. It's the whole point. (153)

[7] Theobald, E.J., et al. (2017). Student perception of group dynamics predicts individual performance: comfort and equity matter. PLoS ONE, 12(7), 1-16; e0181336. https://doi.org/10.1371/journal.pone.0181336

[8] Chambliss, D. F., & Takacs, C. G. (2014). How College Works. USA: President and Fellows of Harvard College.

Table 16. **Choosing another research experience as an undergraduate**

	Frequency	Percent
I will not choose to have another research experience	573	2.7
I am unlikely to choose another research experience	1443	6.9
I am likely to choose another research experience	4650	22.1
I am very likely to choose another research experience	14382	68.3

Table 16 represents the results of a hypothetical question used to probe the student respondents' attitude toward their experience.

Early adopters of the SURE survey asked for a section on program components that were part of many summer research programs. The most frequently requested items appear in Table 17 and Table 18. Student respondents evaluated the effectiveness of the program component. Correlations on annual data sets repeatedly showed the final presentation was most highly correlated with overall learning benefits and satisfaction of all the program components.

Table 17. **Program components** (1 = very negative; 5 = very positive)

	Mean	Median	Mode
Preparing an application or writing a proposal at the start of the project.	3.91	4	4
Seminars at which local or visiting scientists discussed their research.	4.14	4	5
Seminar(s) on safety in the laboratory.	3.65	4	3
Instruction and discussion on ethics.	3.80	4	4
A program of social activities.	3.92	4	4
On-campus housing.	3.93	4	5
On-campus meal plan.	3.39	3	3
The final presentation of work - either a written report, a platform presentation, a poster presentation, or a combination.	4.37	5	5

Table 18. **Rating the program components** (frequency distribution)

Very Negative	Moderately Negative	Neutral	Moderately Positive	Very Positive
Preparing an application or writing a proposal at the start of the project.				
0.8%	**3.4%**	**28.3%**	**39.1%**	**28.4%**
Seminars at which local or visiting scientists discussed their research.				
0.7%	**2.7%**	**18.7%**	**37.7%**	**40.3%**
Seminar(s) on safety in the laboratory.				
1.7%	**6.6%**	**38.4%**	**31.6%**	**21.7%**
Instruction and discussion on ethics.				
1.1%	**4.3%**	**33.4%**	**35.6%**	**25.6%**
A program of social activities.				
1.3%	**4.7%**	**26.5%**	**35.3%**	**32.2%**
On-campus housing.				
4.2%	**7.4%**	**20.8%**	**26.2%**	**41.1%**
On-campus meal plan.				
12.2%	**11.6%**	**29.0%**	**19.3%**	**27.8%**
The final presentation of work - either a written report, a platform presentation, a poster presentation, or a combination.				
0.3%	**1.7%**	**11.8%**	**34.3%**	**52.3%**

Peer Mentoring Experience

From 2011 to 2018 some 1337 respondents identified themselves as peer mentors. Those respondents who indicate that they serve as peer mentors are asked to respond to items about their experience.

Table 18. **Description of tasks (multiple answers permitted)**

Peer mentoring role	**Frequency**	**Rank**
My job explicitly included mentoring or training other undergraduates.	479	**4**
I did some peer mentoring informally.	962	**1**
I taught or trained another undergraduate.	903	**2**
I offered coaching or social support.	546	**7**
I was a role model; students followed my example.	736	**3**
I was responsible for the results of a group of student researchers.	359	**8**
I was given assignments or materials to teach other students.	427	**6**
I was alone with other students as their teacher or trainer.	475	**5**

Table 19. **Preparation for mentoring**

	Frequency
I was assigned to be a peer mentor.	563
I had training on how to mentor.	192
I attended a seminar on how to mentor undergraduates.	89
Mentoring was part of my performance evaluation.	85

Only 192 out of a possible 1337 peer mentors (14.3%) reported having training. Approximately 83% of peer mentors reported having prior research experience.

Table 20. **Rate your experience as a mentor**

	Frequency	Percent
Very negative	3	0.2
Moderately negative	17	1.4
Neutral	104	8.5
Moderately positive	392	32.0
Very positive	708	57.8

Most peer mentors rated their experience as positive, evaluated their work and the impact on their attitudes highly (Table 21), and most would do it again if they had the opportunity (Table 22). When peer mentors report their learning benefits (as in Table 10) their averages are typically higher than those of the general cohort.

Table 21. **Evaluation of mentoring experience** (1 = strongly disagree; 5 = strongly agree)

	Median	Mean	Standard Deviation
I enjoyed the responsibility.	4	4.34	0.77
I enjoyed teaching.	4	4.36	0.77
I gained self-confidence as a researcher.	5	4.44	0.77
I felt that my supervisor did not prepare me for the mentoring role.	2	2.41	1.10
My oral communication skills improved.	4	3.94	0.86
I was given responsibility beyond my experience.	2	2.69	1.20
I felt pressure to make sure the other undergraduates did well.	3	3.19	1.10
I felt responsibility for the research.	4	4.17	0.90
I was on my own too often.	2	2.35	1.00
My role deepened my understanding of the research project.	4	4.21	0.84
My role increased my motivation to work on research.	4	4.07	0.91
I did well as a peer mentor.	4	4.07	0.73

Table 22.**Would you mentor in the future?**

	Frequency	Percent
Yes	1154	96.9%
No	37	3.1%

Table 23. **If you worked with a peer mentor, please indicate how strongly you agree or disagree with the following statements** (1 = strongly disagree; 5 = strongly agree).

	Median	Mean	Standard Deviation
My peer mentor helped me appreciate the significance of the research.	5	4.38	0.84
My peer mentor understood my concerns.	5	4.38	0.86
I asked the mentor questions I was afraid to ask my supervisor.	4	3.85	1.2
I would have learned more if there had been no mentor.	1	1.75	1.1
I feel the use of mentors enabled faculty and graduate mentors to ignore me.	2	2.05	1.1
My peer mentor had a positive impact on my research experience.	5	4.37	0.9

Students who did not identify as a mentor but reported that they had worked with a peer mentor were given an opportunity to evaluate that experience (Table 23). The pattern of responses indicate that the mentor enhanced their experience. Students who reported having a peer mentor evaluated their learning benefits (as in Table 10) slightly higher than the general cohort.

In another of my statistical summaries (ROLE Survey Statistics, found on this site) I point out that Deming (1953)[9] distinguished between enumerative and analytic surveys. An enumerative survey answers the question, "how many?" or to what degree, but does not answer the question, "why?" as might be expected from an analytic survey. The numbers are required to speak for themselves, but not to interpret themselves. The causal alignment of the survey data with features of the UR program depends on the judgement of the program evaluator.

[9] Deming, W. E. (1953). On the distinction between enumerative and analytic surveys. *Journal of the American Statistical Association, 48*, 24-255.