Research Supervisors and Undergraduate Students' Perceived Gains from Undergraduate Research Experiences in the Social Sciences

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Undergraduate research experiences (UREs) enhance student retention, provide transferrable skills, and prepare students for advanced graduate study. The majority of these benefits, however, are concentrated within the natural and biological sciences; disciplines with historical under-representation of non-male students. If offered in the social sciences, UREs would be more accessible to women, students of colour, and first-generation students. But there are relatively few models and little research to confirm that UREs in the social sciences offer similar benefits to students. Using mixed methods data, we compare students’ (n=122) and research supervisors’ (n=56) perceptions of success in meeting learning outcomes for students participating in social science UREs. The combination of quantitative and qualitative survey data shows that students gain skills in research (e.g., data collection, management, and analysis) as well as other transferrable skills helpful in various career paths (e.g., collaboration, time management, problem-solving). We also demonstrate that faculty supervisors perceive significant benefits from overseeing UREs, such as enhancing professional development and increased job satisfaction. These findings demonstrate the need for expanding UREs beyond the biological/natural sciences where they have been focused to date.

Keywords: undergraduate education; student research; mentoring; social science; UREs

Introduction

Undergraduate research experiences (UREs) provide students with a unique opportunity to participate in research early in their academic careers. A wide range of URE experiences exists, encompassing student-led initiatives, community-focused projects, individual research apprenticeships/internships, course-based opportunities, summer intensive programs, and lab experiences (Brownell et al. 2015; Gentile, Brenner, and Stephens 2017; Hvenegaard et al. 2013; Ruth, Brewis, and SturtzSreetharan 2021; Ruth et al. in press). For undergraduate students, participation in mentored UREs can build skills and confidence, cultivate research career trajectories, and facilitate retention by fostering institutional commitment (Kilgo, Sheets, and Pascarella 2015; Kuh 2008). Mentorship and retention of undergraduate students—especially first-generation students, students of colour, and other under-represented students—is particularly important for cultivating diversity within the academy and fixing “leaky pipelines” that result in maintaining educational inequities (Deanna et al. 2022; Gasser and Shaffer 2014; Hernandez and Lopez 2004). UREs can also benefit research mentors. They provide opportunities for researchers to collaborate with students, and they open pathways for researchers to incorporate students’ diverse knowledge, perspectives, and skills into ongoing projects, hone mentor’s research skills, and provide an enjoyable experience (Beresford et al. 2022; Moore, Hvenegaard, and Wesselius 2018). Expanding undergraduate research experiences (UREs) can thus be both an institutional and a pedagogical goal.

Following the release of the Boyer Commission Report in 1999, there has been a consistent call to identify ways to diversify and scale research opportunities for undergraduates, both across institutions and academic disciplines (Healey and Jenkins 2018; Katkin 2003). Historically, UREs are more heavily represented in the science, technology, engineering, and mathematics (STEM) fields (Crowe and Brakke 2019; Linn et al. 2015). But efforts within non-STEM disciplines have been growing (Crawford and Shanahan 2014; Crowe and Boe 2019; Cuthbert, Arunachalam, and Licina 2012; DeVries 2001; Ishiyama 2002; Klos, Shanahan, and Young 2011; Levenson 2010; Parker 2012; Thies and Hogan 2005; Ruth, Brewis, and SturtzSreetharan 2021; Wessels et al. 2020).

Yet, we still know relatively little about the effectiveness of UREs within the social sciences (Katkin 2003; Crowe and Brakke 2019; Seymour et al. 2004). For example, do social science-based UREs yield similar benefits to those observed in the biological and natural sciences? Are faculty in the social sciences able to implement UREs in ways that satisfy their goals alongside those of students, such as in fields without a string model of lab-based instruction? And, how does this effort relate to efforts to bring UREs to more diverse students?

Our study addresses these questions, building from what is currently known about the benefits of UREs to students and the types of opportunities currently offered.

Student benefits of undergraduate research involvement

High impact practices (HIPs) are active learning experiences at the undergraduate level that increase student retention and engagement (Kuh 2008). Research involvement is one HIP that develops students' technical skills, critical thinking, collaboration skills, and responsiveness to new challenges (Kuh 2008; Kilgo, Sheets, and Pascarella 2015; Landrum and Nelsen 2002). They also learn how to work independently and overcome obstacles, and they improve their logic and analytical reasoning (Lopatto 2004; Ishiyama 2002). Students who engage in research are better retained, have improved self-confidence, and have more concrete career aspirations (Russell, Hancock, and McCullough 2007). These findings, however, are based on students' perceived outcomes; studies on UREs do not include research supervisors' perspectives on learning (Linn et al. 2015). We took this into account and therefore surveyed both students and URE supervisors about specific learning outcomes.

Students who participate in UREs learn to think and practice in their respective disciplines (McCune and Hounsell 2005). Students who complete UREs are more likely to self-select into science[1]-related careers (Kuh 2008; Russell, Hancock, and McCullough 2007). They also have more successful applications for graduate school (Nnadozie, Ishiyama, and Chon 2000) and are more likely to enrol in graduate programs (Crowe and Brakke 2008). First-generation students (those whose parents do not have 4-year degrees and tend to be non-White and women [Núñez and Cuccaro-Alamin 1998]) often live at home, work in low-wage jobs, and have familial responsibilities that make it challenging to find and commit to extracurricular activities (Pascarella et al. 2004), like UREs. Undergraduates who do not get involved in research often do not know about opportunities, find out about them too late, or feel too intimidated to ask faculty about them (Wayment and Dickson 2008). Yet, UREs have the prospect of encouraging more women and students of colour to pursue science-related career pathways (Eagen et al. 2013;

[1] The use of 'science' incorporates social science and other endeavors "whose goal is to acquire objective knowledge" about the world and "to use that knowledge to meet human needs" (Bernard 2012: 20798)

Hurtado et al. 2009; Lopatto 2004). This begs the question: how we can make these experiences open and easily available to more students?

Types of undergraduate research experiences

Generally, UREs have been difficult to access for students. They are usually offered at well-resourced institutions and are reserved for high-achieving students within highly selective STEM fields heavily represented by males (Katkin 2003; Rand 2016; Steele, James, and Barnett 2002). Recent attention on direct study research, where students carry out their own projects under the supervision of a faculty member, shows similar benefits to other types of UREs (Moore et al. 2018). Traditionally, however, undergraduate research experiences have been reserved for more advanced students and involved a faculty-student or faculty-small group mentorship experience (Seymour et al. 2004). UREs have also historically relied upon faculty mentorship in a lab-based apprenticeship model (Katin 2003), further limiting these experiences to STEM fields.

One way to increase access is through course-based undergraduate research experiences (CUREs), where capacity is scalable because the experience is an open-enrolment class (Brownell et al. 2015). Social science CUREs provide similar outcomes to STEM CUREs in that they improve access for women, students of colour, and first-generation students (Bangera and Brownell 2014; Ruth, Brewis, and SturtzSreetharan 2021). They also improve self-confidence, the ability to analyse data, think critically, tolerate obstacles, and work collaboratively (Ruth, Brewis, and SturtzSreetharan 2021). While CUREs offer a mechanism for students to access research experiences, they are time and resource intensive for mentors, and they require expertise and agility in both research and teaching (Ibid.). Thus, relying solely on CUREs to expand student research opportunities is not advisable.

Recently, social scientists have been building and testing lab models for undergraduate research (Becker 2019; Weinschenk 2020). However, individual research labs that are not capacitated to scale have limits to the number of students they can involve; STEM labs that have more than twenty students often have graduate student mentors assuming the day-to-day responsibilities with faculty acting as research managers (Crede and Borrego 2012). This can often be the case in STEM fields, such as engineering, where graduate students work as part of a research group and their dissertation research is derived from the lead faculty member's current research (Deem and Brehony 2000). This STEM model is different from the social sciences, where graduate students may be part of a lab as their research assistantship or general affiliation and then often work as lone scholars on their own research, meeting with their advisors regularly (Deem and Brehony 2000).

The research question and case study

We use a case study of a scaled social science program designed to offer UREs to a larger number of more diverse students than is typical of traditional (often STEM-based) UREs. Using retrospectively collected mixed-method data, we assess the perceptions of participants in benefits gained through social science UREs in three ways: (1) perceived student gains as understood by students; (2) perceived student gains as understood by supervisors/mentors who create and oversee these experiences; and (3) perceived benefits for supervisors offering UREs. Our research questions are: (1) *Do students in scaled social science UREs perceive benefits like transferable skills, research skills, networking, personal growth, and career direction similarly to what has been reported for more traditional STEM UREs? (2) Do research supervisors perceive the same student-learning benefits? (3) What are the perceived benefits to research supervisors who deliver UREs?*

The case study includes students and mentors participating in UREs in a large social science School in the US Southwest. The School is home to 61 faculty, 53 of whom are tenured/tenured eligible faculty. In 2020-2021, there were 935 majors across four undergraduate degree programs, 62% of whom were White, 19% Latine[2], and around 5% each identified as Asian, Black, or two or more races, and 2% Indigenous American. The majority of majors are female (77%). There are 110 doctoral students, 66% of whom are female, 60% White, 12% Latine, 2% Black, 2% Asian, 4% two or more races/ethnicities, 1% Indigenous American, and 17% International. The faculty are highly research active, generating over 20 million in external grant requests during 2020-2021 academic year.

Some faculty manage large labs with more than 20 graduate and undergraduate students affiliated per semester, others run smaller labs of 3-5, and others may integrate one or two students at a time into research activities outside of a physical lab. Graduate students who belong to labs may help faculty with their research through their funded research assistantships, but

[2] Latine is a gender neutral term to identify those of Hispanic heritage and aligns with Spanish grammar and pronunciation (see Slemp 2020 and Zentella 2017).

most graduate students are expected to conduct their own dissertation research. To help increase access to research experiences, our School encourages graduate students, post-doctoral scholars, and faculty to offer UREs, regardless of the stage of the researcher or project(s) and dedicated lab space.

In 2011, we created our School's Undergraduate Research Apprenticeship Program (URAP). Before this program, faculty largely recruited students for UREs via word of mouth during office hours or in their classrooms. To increase and flatten access to UREs for all students, we centralised and formalised the process. First, we solicit details of all potential UREs from potential mentors – faculty and advanced graduate students – before the start of each semester (graduate students who suggest a position must do so under the supervision of a named faculty). Student advising staff then advertise all available positions to the full student body via a centralised website and student email listserv. Students apply directly to a position via a common application. In addition to writing a brief narrative about their interest in the position, the application asks them to indicate the number of hours they are available to work each week; students earn course credits accordingly (e.g., 3 hrs/week = 1 credit, 6 hrs/week = 2 credits, etc.). Applications are routed directly to faculty and graduate student PIs/Co-PIs to evaluate and "hire" based on their need for the position, though PIs/Co-PIs are encouraged to evaluate applicants based on a students' potential and expressed interest in the position, as opposed to focusing solely on potentially biased metrics such as GPA or previous research experience. Today, the program continues to place 75+ undergraduate students into UREs with 20+ participating faculty each semester. Since 2011, over 1,100 students have participated in the program (i.e., completed at least one semester of a URE). Of those students, 77% were women, and 42% identified as Black, Indigenous, Latine, Asian, or mixed-race/ethnicity.

Methods and materials

Data collection

In May 2021, we deployed two surveys, one for students who completed a URE and one for supervisors of UREs (including faculty and advanced graduate students qualified to supervise undergraduate research). Surveys included the following items related to potential gains: 17 from the Survey of Undergraduate Research Experiences (SURE) scale (Lopatto 2007, 2004), three added questions relevant to a social science context (working collaboratively, learning social science laboratory techniques, and understanding social science) and 17 adapted from the Landrum and Nelsen (2002) study of faculty perceptions of benefits on the abilities students gained (not captured with the SURE) that aligned with faculty's instructional conditions (e.g., questions about quantitative or qualitative research tasks).

Responses for each of the 37 items were assessed on a scale of 1-5 with 1 = no or very small gain, 2 = a small gain, 3 = moderate gain, 4 = large gain, and 5 = a very large gain. A score of three or more indicates that students, on average, perceived moderate or greater gains in elicited items; a score of 2 was taken to reflect little or no perceived gain. Data collection also included qualitative (open-ended) responses designed to elicit context around the surveyed items. For example, students were asked to describe the most valuable skills and lessons they learned whereas supervisors were asked to describe the benefits they perceived for themselves. The research was approved under Arizona State University's IRB (STUDY00003652).

Student and Mentor Recruitment and Response. We sent 1077 unique emails to undergraduate students who were enrolled in research apprenticeship (i.e., URE) credit hours between the years of spring 2011 and spring 2021 (many of the students participated online in Fall 2020-Spring 2021). Of the 550 students who opened the email, 147 responded (24% response rate) with ~25 partially responded for a total of 122 (22% full response rate). Respondents were 91 female, 25 male, 3 nonbinary, and 3 non-responses. Racial and ethnic backgrounds of students (using common US higher education designations) included: 67 White, 17 Latine, 16 Asian, 3 two or more race/ethnicities, 2 Black, 2 Indigenous American, and 15 not reported. As for parental degree attainment, 37 were first-generation students (30%), 82 continuing generation (at least one parent/guardian has a 4-year degree), and 28 were not-reported. The percentage of first-generation student respondents is representative of our total school's first-generation undergraduate population (~27%). As for parental graduate degree attainment, only 45 (30%) of the total sample indicated that one or more parents had an advanced degree. We emailed 127 faculty and graduate students who supervised various research experiences. We received 56 responses (44% response rate). Of these, 26 were faculty and 30 were advanced graduate students supervising undergraduate research. Further demographic information was not requested to maintain adequate confidentiality of responses.

Analytic strategy

Scalar data were cleaned in excel and then analysed statistically using SPSS version 22. Student versus faculty mean responses were compared using t-tests, with alpha set at 0.05 to identify if these were significantly different. We also compared student responses from the social science UREs to the STEM student data provided by Lopatto (2007) for matching response items.

Qualitative analysis of the open-ended responses included using inductive techniques of theme identification to identify salient themes across the data set (Ryan and Bernard 2003). We specifically looked for themes relating to perceived gains. Once salient themes were identified, we created structured codebook definitions following the method outlined by MacQueen et al. (1998), and then coded the data using VERBI Software MAXQDA. Our results describe the most salient themes in the data set and show exemplar quotes that depict both the central tendency and range of each theme (Bernard, Wutich, and Ryan 2016).

Quantitative results

Results comparing student to faculty perceived gains for 37 question items are presented in Table 1, with comparison to Lopatto study scores for comparable items in Figure 1. These show that students (orange dots) perceived moderate or significant gains on all 37 items (mean score > 3) with the highest gain scores (>4) for: understanding that scientific assertions require supporting evidence, ability to manage/organize data, and learning ethical conduct in research with human subjects. Faculty (grey dots) reported more mixed assessments with three items scoring, on average, less than 3 (skill in oral presentations, academic writing, producing graphs and tables). Faculty perception of student gains was greatest for: 1) understanding what is social science, 2) understanding the research process, and 3) understanding how social scientists work on problems. Results of significance tests comparing student and faculty responses are presented in Table 1. Students consistently perceived more gains than faculty across all survey items. Nine of these were statistically significantly different and, for all significant differences, students perceived the greater gains from UREs. These results are meaningful because they exceed family-wise error expectations.

Figure 1 also compares student responses from our study (orange dots) to those of Lopatto (2007)(blue dots) focusing on perceived student gains in STEM fields for the subset of 17 overlapping survey items. Both studies showed student-perceived improvements, which indicates that social science UREs can meet many of the same general skills development goals as STEM-based UREs. The social science URE notably exceeded STEM URE data on two survey items: 1) skills related to ethics, and 2) the ability to integrate theory with practice. STEM students surpassed social science students on two survey items: 1) skills related to using primary literature, and 2) practice at oral presentations.

[INSERT FIGURE 1 ABOUT HERE]

[INSERT TABLE 1 ABOUT HERE]

Qualitative results

Here, we present exemplar quotes in Table 2 for four thematic and salient categories based on students' responses to their perceived gains.

[INSERT TABLE 2 ABOUT HERE]

Perceived gains – students

Transferrable skills. Half of the students (49%) reported learning a wide range of transferrable skills. Given the range of experiences available, these skills spanned qualitative and quantitative arenas. They included self-confidence, thinking critically, being objective, teamwork, empathy, social skills, approaching and recruiting participants, analytical skills, tolerating obstacles, collaboration abilities, time management, problem-solving, and improved technology skills. These examples highlight the benefits that students believed they gained as part of their participation in a URE. These hands-on, collaborative experiences allowed for professional development that is essential in many careers, not just research.

Research skills. Over a third of students (35%) discussed developing skills that are specific to the research process and overall understanding of doing research such as study design, implementation, and analysis. This included learning about the research process, from reading and compiling literature, to data collection, entry, checking, coding, and analysis. Importantly, students talked about learning the scientific process and how to think like social scientists. This includes the types of questions we ask, the ethics of research, collecting objective data, and working on collaborative research teams. These research-related skills better prepare students who chose to go on to pursue advanced research degrees (Nnadozie, Ishiyama, and Chon 2000).

Developed valuable relationships. One-fourth of the students (25%) discussed developing relationships with supervisors and peers. These relationships allowed for mentorship, advice, comradery, and a sense of belonging. URE participants discussed building valuable relationships with faculty, graduate students, and post-doctoral researchers. Some students also mentioned building relationships with their peers who were also a part of the same research project. These relationships were seen as valuable, producing friendships as well as receiving career advising, mentorship, and letters of recommendation.

Honed career path and confidence. Some students (22%) mentioned the experience helped them decide to pursue graduate studies as well as gain confidence in their abilities.

Although a smaller percentage of students mentioned the effect on their career paths, some students found these experiences empowering to pursue specific careers. The hands-on skills they learned were recognised as something they could apply in the real world, pointing to the fact that these experiential learning exercises are powerful learning opportunities (Kolb and Kolb 2009; Kuh 2008).

Perceived gains - research supervisors

Instead of further asking research supervisors what skills they thought students gained, we asked them to describe the benefits they experienced in serving as mentors of research apprentices. Below, and in Table 3 we highlight three benefits: developed skills, advanced research, and personal/career benefits.

[INSERT TABLE 3 ABOUT HERE]

Developed skills. Over half of research supervisors (53%) mentioned developing a variety of skills as a result of their participation in the research apprenticeship program. They reported improved skills in mentoring, leading teams, managing mentees, managing data, solving problems, and understandably presenting research. The comments about developing skills were mainly from younger scholars, including graduate students, post-doctoral scholars, and junior faculty. Having the opportunity to supervise and mentor undergraduate students was noted to be a benefit of supervising UREs that can be utilised in future careers.

Advanced research. Many supervisors (43%) stated that they were able to advance their research projects because research apprentices allowed them to collect, catalogue, clean, and manage large amounts of data that they would not have been able to do otherwise. Students also help conceptually with project design by asking questions and providing feedback.

The ability to advance research is evident in these responses, but notably, these responses also highlight the unique perspectives, insights, and contributions that students provide to the research. Many faculty and graduate students incorporated undergraduate research apprentices as co-authors on presentations, posters, and peer-reviewed publications (>30 peer-reviewed publications reported by supervisors in the survey). When done well, incorporating undergraduate students into research can produce benefits for both the students and the faculty (Osborn and Karukstis 2009; Zyndey et al. 2002).

Personal and career benefits. A quarter of research supervisors (24%) mentioned gaining a sense of fulfilment and job satisfaction through mentoring apprentices. They enjoyed helping them develop skills, seeing them grow, and providing letters of recommendation for them. These insights are important to recognise. Beyond advancing careers, feeling good about the work you are doing can also improve job satisfaction for URE supervisors (Osborn and Karukstis 2009). This in turn can encourage more researchers to provide such opportunities.

Discussion and conclusion

This research provides additional support that establishing successful undergraduate research experiences need not be confined to traditional lab spaces nor the STEM fields. Results from our mixed-methods study demonstrate that students, from a range of social backgrounds, perceived gains from participation in a URE, especially in managing data and understanding ethics. Faculty in turn reported that students benefited most by improved understanding of social science and research processes. Overall, students and faculty agreed that there was an improvement of research-skill development. And interestingly, social science students report greater gains in research ethics, similar to another study on social science CURES (Ruth, Brewis, and SturtzSreetharan 2021), suggesting that working with human subjects and the related requirements for ethics training may result in greater gains than natural science students.

Student qualitative responses show that involvement in UREs has far-reaching benefits beyond learning to do research. Students gained transferrable research skills, honed their career interests, and made valuable relationships. These taken together show why UREs are a high-impact practice that favourably impact students and their academic outcomes (Kuh 2008), not just in STEM. These findings also demonstrate that access to research experiences can be offered to a greater diversity of students (e.g., by implementing programs that increase access) in a variety of disciplines (outside STEM) and prove to have highly beneficial outcomes. They gained a range of transferrable skills including objectivity, critical thinking, time management, problem-solving, working collaboratively, as well as research skills such as collecting, managing, and analysing data. The research skills they gained can help them get into competitive graduate programs through strong applications where they can highlight their experiences (Crowe and Brakke 2008; Nnadozie, Ishiyama, and Chon 2000). Students also built a valuable sense of connection and building relationships, which is key when trying to encourage students, especially historically marginalised students such as students of colour and women, to feel like they belong and have long-lasting academic success and continue to pursue research-related careers (Fisher et al. 2019; Walton and Cohen 2007).

Research supervisors, who included faculty, graduate students, and post-doctoral researchers, also saw benefits from these experiences. Faculty often believe that offering UREs are burdensome with most benefits going to students (Lopatto 2010; Nolan et al. 2020), but this does not need to be the case. URE supervisors improved their mentorship abilities, advanced their research, included different perspectives in their research, and felt rewarded for their work with undergraduate students. Improvement in mentoring students was especially important for junior scholars—particularly graduate students—which is beneficial as they develop into their professional positions (Zyndey et al. 2002), an underrecognised and understudied aspect of graduate student training. Newer mentors may benefit from some best practices such as strategic planning, setting and scaffolding expectations, teaching needed skills, providing emotional support, building community, assisting with students' professional development, and finding pathways for students to present findings (Shanahan et al. 2015).

In this paper, we have outlined how we have successfully implemented an Undergraduate Research Apprenticeship Program in order to increase access to research experiences for students in the social sciences. Not only has this increased the number of students trained, but it has also provided valuable skills-building for the students and research mentors. The study's limitations stem from the sampling strategy, as only 27.9% of potential participants responded. This could introduce bias in the results if, for instance, students with more positive experiences were more likely to participate. Additionally, each student's experience can greatly differ, regardless of the type of URE, due to variations in research projects and tasks across semesters and mentors. It is important to note that this study focused on students' perceived learning rather than actual learning. Future research could incorporate pre/post-tests to measure learning outcomes as well as study research experiences in other disciplines. Nevertheless, social science UREs hold the potential to provide impactful student experiences, similar to the outcomes observed in physical and life science UREs (Lopatto 2004; Ishiyama 2002; Russell, Hancock, and McCullough 2007). We hope that others can model this type of program to increase access to students who may be historically underserved (e.g., based on race/ethnicity, class, immigrant status, etc.) in their respective institutions.

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							95% Confidence Interval of the Difference	
Skill Item	**Student mean score N=122**	**Faculty mean score N=56**	**Student SD**	**Faculty SD**	***t***	***p***	**Lower**	**Upper**
Clarification of a career path	3.68	3.52	1.23	1.08	-0.85	0.40	-0.53	0.21

Skill in the interpretation of results	3.81	3.48	1.33	1.19	-1.61	0.11	-0.73	0.07
Tolerance for obstacles faced in the research process	3.70	3.53	1.19	0.96	-0.91	0.37	-0.51	0.19
Readiness for more demanding research	3.80	3.71	1.20	0.87	-0.46	0.65	-0.43	0.27
Understanding how knowledge is constructed	3.87	3.77	1.11	0.93	-0.55	0.58	-0.42	0.24
Understanding of the research process in your field	3.87	4.03	1.23	0.82	0.91	0.36	-0.19	0.51
***Ability to integrate theory and practice**	3.55	3.03	1.34	1.08	-2.58	**0.01**	-0.91	-0.12
Understanding of how scientists work on real problems	3.80	4.03	1.20	0.92	1.35	0.18	-0.11	0.59
***Understanding that scientific assertions require supporting evidence**	4.00	3.52	1.31	1.10	-2.43	**0.02**	-0.87	-0.09
Ability to analyze data and other information	3.88	3.57	1.31	1.31	-1.50	0.14	-0.72	0.10
***Learning ethical conduct in research with human subjects**	4.21	3.26	1.48	1.42	-4.12	**0.00**	-1.41	-0.50
***Ability to read and understand primary literature**	3.88	3.05	1.32	1.86	-3.47	**0.00**	-1.30	-0.36
***Skill in oral presentations**	3.50	2.90	1.81	1.68	-2.14	**0.03**	-1.16	-0.05
Skill in science writing	3.52	3.66	1.81	1.04	0.55	0.59	-0.36	0.64
Self-confidence	3.65	3.74	1.28	1.16	0.47	0.64	-0.30	0.48
Understanding of how (social) scientists think	3.79	3.91	1.22	1.00	0.66	0.51	-0.24	0.48
Learning to work independently	3.99	3.91	1.18	1.17	-0.42	0.67	-0.45	0.29
Learning social science laboratory techniques	3.74	3.64	1.48	0.97	-0.48	0.63	-0.52	0.32

Understanding what is social science	3.93	4.24	1.21	1.73	1.41	0.16	-0.12	0.75
Learning to work collaboratively	3.87	3.79	1.20	1.11	-0.40	0.69	-0.45	0.29
Ability to develop effective research questions	3.62	3.26	1.51	1.41	-1.54	0.13	-0.83	0.10
***Ability to gather and synthesize qualitative and quantitative data from published sources**	3.80	3.26	1.46	1.61	-2.24	**0.03**	-1.02	-0.07
Ability to develop surveys and questionnaires	3.81	3.47	1.69	2.11	-1.16	0.25	-0.93	0.24
***Ability to choose appropriate measures for data collection and/or research design**	3.79	3.19	1.55	1.55	-2.43	**0.02**	-1.10	-0.11
***Ability to manage/organize data**	4.11	3.75	1.14	0.92	-2.08	**0.04**	-0.70	-0.02
Ability to thematically code qualitative data	3.70	3.72	1.64	1.81	0.10	0.93	-0.51	0.57
Ability to analyze qualitative data	3.91	3.46	1.42	1.78	-1.82	0.07	-0.95	0.04
Ability to prepare data for statistical analysis	3.61	3.09	1.76	1.61	-1.90	0.06	-1.06	0.02
Ability to analyze quantitative data	3.58	3.09	1.63	1.72	-1.84	0.07	-1.02	0.04
Ability to use quantitative/statistical data management programs	3.45	3.05	1.72	1.74	-1.44	0.15	-0.95	0.15
Ability to use qualitative data management programs	3.51	3.40	2.05	2.08	-0.35	0.73	-0.77	0.54
Ability to use other computer programs used for research	3.56	3.41	1.72	1.52	-0.56	0.57	-0.68	0.38
***Ability to write academically**	3.50	2.84	1.72	1.68	-2.38	**0.02**	-1.20	-0.11

Ability to produce graphs and tables	3.44	2.91	1.89	1.56	-1.82	0.07	-1.09	0.04
Ability to prepare conference presentations for a poster format	3.34	3.48	2.03	1.87	0.44	0.66	-0.49	0.77
Ability to prepare conference presentations in an oral format	3.34	3.09	1.95	1.99	-0.81	0.42	-0.88	0.37
Ability to co-author research publication(s)	3.28	3.21	2.03	2.04	-0.21	0.83	-0.71	0.58
Ability to co-author research publication(s)	3.28	3.21	2.03	2.04	-0.21	0.83	-0.71	0.58

Table 1: Results of the Student's T-test Assessing Differences between Faculty and Student Scores on Individual Items. *Students perceive greater gains than faculty.

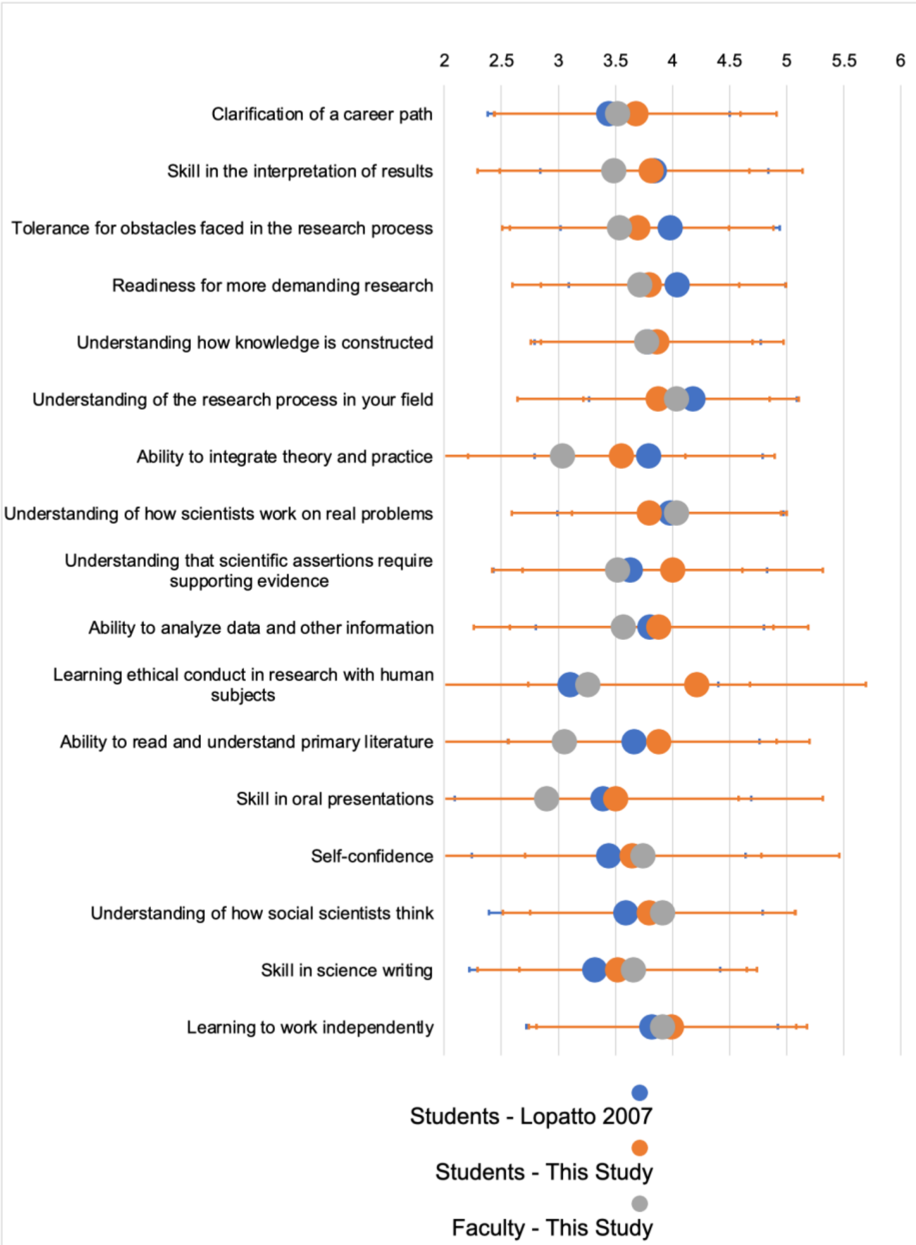

Figure 1: Mean reported values for individual items, comparing students and faculty perceptions in this study and survey scores provided by Lopatto (2007) for science students for matched items. Whiskers represent standard deviations.

Theme	Exemplar Quotes – Students	Demographic Info
Transferrable Skills	*In one of my research apprenticeships I had the opportunity to interview a few dozen people, which has helped me become more comfortable asking questions and directing conversations with ease, all of which will help me when sitting down with clients and other attorneys.*	female, Indigenous American, first-generation
	I learned how to interact with people, be more collaborative, and I learned many professional skills that I have not learned elsewhere in college. I would say that the most valuable lesson I learned in the lab was self-discipline working alone and more confidence in speaking up and talking to professionals and professors. Also learned how to interact with people who are different than me and those who have different goals and attitudes.	female, white, continuing-generation
	The biggest benefit of my experience in social science/ qualitative research was learning the importance of asking why and how people think certain ways, and using those answers to inform solution-making. I felt that the process of gathering qualitative data taught me important qualities that would later be applied to my medical school experience, including patience and most importantly, understanding others' perspectives and how their perspectives inform their decisions.	female, Asian, continuing-generation
Research Skills	*Entering surveys and performing quality control helped me be more detail-orientated. Working with software such as SPSS and Excel were important for learning more tips and tricks with coding and organizing large portions of data.*	female, race/ethnicity undisclosed, first-generation
	I learned how to center populations that I am working with and treat all of my collaborators with dignity and respect regardless of their background. In terms of skills I learned a lot rigorous research methodology and how to spot good data from bad data. I learned about qualitative and quantitative research methods.	female, Black, continuing-generation
	The most valuable skills I gained is how to conduct interviews and process the information from each interview. […] I learned how to conduct an interview without showing bias, understanding and patience with each participant, and the importance of human connections.	female, white, first-generation
Developed Valuable Relationships	*Being part of a research program also meant being part of a learning community where I was able to meet other students who were interested in similar fields and faculty who were doing research in interesting fields and topics.*	female, Latine, first-generation
	While the lab provided me with many helpful skills, whether it be coding, statistics, paper reading, etc., my greatest take away was how fun it was. The lab really built a community of peers that made doing, discussing, and analyzing the work fun and interesting. We met once a week, and it was always a highlight for me. I loved talking about our findings with my lab mates.	non-binary, Latine, continuing-generation
	I really appreciated when my advisors/grad students in the research lab offered career advice, CV building, and tips for grad school. I like	female, white, continuing-generation

	knowing that not only can I come to them for research advice, but career advice as well.	
Honed Career Path and Confidence	*Gaining the self-confidence to be in my field that I always wanted as well as experience that will set me apart from many other candidates. The research I was a part of sparked something inside of me and my colleagues inspired me immensely. I learned the value of research as well as basic lab skills that prepared me for several jobs and my career.*	female, Latine, first-generation
	Through my research apprenticeship experience, I gained an understanding of how social science research is conducted, as well as hands-on experience with data management/analysis. I was given the support to develop my own research project, which then helped me gain the confidence to pursue graduate school. The experience directly impacted my career trajectory and was the starting point for my interest in public health and citizen science.	female, white, continuing-generation
	The apprenticeships gave me an application of skills that I would use in the workforce and helped me to learn about what I like and don't like.	male, Latine, continuing-generation

Table 2: Students' exemplar quotes by thematic category.

Theme	**Exemplar Quotes - Research Mentors**	**Faculty/Grad Student**
Developed Skills	*I was able to continue mentoring students I had taught from classes I had been the lecturer or TA in, which allowed for many teachable moments. Developing this kind of relationship has also taught me management skills, effective team building, and individualization of teaching methods for my different students.*	Graduate Student
	It has helped me hone my mentorship skills and better understand what does and doesn't work while mentoring undergraduates within experimental archaeology. Ultimately, the RAP provides me an opportunity to give back to students. I would never have made it into graduate school without the help of graduate students and I strive to provide the same type of mentorship and advice to any student that needs it.	Graduate Student
	Improved communication skills, honed management skills, learned to relate research skills to competencies, boosted my enthusiasm for my work and provided a sense of fulfilment.	Faculty

Advanced Research	*Students have completed valuable research. Many posters and papers have benefitted from students' skills in graphic design. Students have actively assisted in science communication for general audiences, such as community reports and websites. Students have brought unique skills to my projects including GIS skills and statistical skills that have been helpful in creating and analysing data.*	Faculty
	Working with the students, we were able to process a much larger number of samples in a shorter amount of time than I would have been able to do on my own. As a graduate student at the time, I also gained valuable mentoring and teaching skills.	Graduate Student
	It is great to interact with students from such different backgrounds and career goals. It is valuable for me to have people from such different backgrounds view the project and provide interpretations in ways that I may not have thought about.	Faculty
Personal and Career Benefits	*I learn a lot from the students and their diverse perspectives. I enjoy seeing them grow as they practice key skills--analysis, writing, team-based collaboration …]*	Faculty
	Personally I feel more connected to ASU and SHESC [the school] and the overall goal of the university, which is to foster student education. Feel a greater connection to my lab and the people working in it.	Graduate Student
	Mentoring students is among the most rewarding parts of my work. Seeing someone go from interest, to engagement, to mastery is very exciting and just generally makes you feel good. When students develop to the point of collaborative publishing and conference presentations, that also comes with the great benefit of being a co-author, although this is rare and should not be expected as the norm.	Graduate Student

Table 3: Research mentors' (faculty and graduate students) exemplar quotes by thematic category.