Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 35-56.
doi: 10.14434/josotl.v21i1.30842

Expectations for and Quality Experiences in Undergraduate Research Over Time: Perspectives of Students and Faculty

Jillian Kinzie
Indiana University Bloomington
jikinzie@indiana.edu

Allison BrckaLorenz
Indiana University Bloomington
abrckalo@indiana.edu

Abstract: Attention to undergraduate research (UGR) is not surprising given its widespread appeal and evidence of educational benefit. Tracking participation and identifying equity gaps in UGR are important markers of access to and equity in educationally beneficial experiences. Information about students' exposure to elements of quality in UGR and how this corresponds to faculty perspectives and instructional practice can help inform efforts to advance and improve UGR. In this article, we use 7 years of data from the National Survey of Student Engagement (NSSE) to explore the national landscape of UGR by examining the responses of 972,088 1st-year students who reported that they planned to participate in UGR before they graduated and the responses of 1,248,854 senior students who reported that they had done or were currently involved in a UGR experience. To complement our student perspectives, we present perspectives on faculty importance of and instructional practice in UGR with data from NSSE's companion survey, the Faculty Survey of Student Engagement, by examining the experiences of 106,000 faculty respondents. Our presentation of descriptive statistics provides a national overview of UGR participation by a variety of salient institutional and student characteristics, a broad summary of faculty involvement in UGR, and baseline data about students' exposure to elements of high-impact UGR.

Keywords: student engagement, faculty practice, survey.

Over the past three decades, interest in undergraduate research (UGR) has grown. Boosted by national organizations and policy groups calling for transformation in undergraduate education in science, technology, engineering, and mathematics (STEM), instructional practices that are more engaging and effective at helping all students learn, and calls to increase diversity in STEM majors, many colleges and universities have enhanced UGR and creative activities (Boyd & Wesemann, 2009; Henderson, Beach, & Finkelstein, 2011; Kinkead, 2003; Weaver, Burgess, Childress, & Slakey, 2016). Research experiences have grown from the time-honored apprentice model, which reserves research for elite, upper division science students, to early exposure to research in the 1st year, and even to whole classes of students addressing a research question or problem of interest to community stakeholders.

Attention to UGR is not surprising given its widespread appeal and evidence of educational benefit. Students value exploring their own questions and deepening their research expertise, while faculty appreciate a pedagogical approach that supports the integration of their roles as scholars and teachers and their service as community members. Encouraged by the popular high-impact practice (HIP) movement, which in 2007 began the collective elevation of long-standing enriching experiences including service learning, research with faculty, and culminating experiences (Kilgo, Ezell Sheets, & Pascarella, 2015; Kuh, 2008; Kuh & O'Donnell, 2013), more colleges and universities strove to expand students' participation in UGR (Lopatto, 2010; Webber, Nelson Laird, & BrckaLorenz, 2013).

Evidence of the positive association between UGR and desired student outcomes such as critical thinking, problem solving, research skill development, and enrollment in graduate education is strong (Bhattacharyya, Chan, & Waraczynski, 2018; Collins et al., 2017 Eagan et al., 2013; Hernandez, Woodcock, Estrada, & Schultz, 2018; Hunter, Laursen, & Seymour, 2007; Hurtado et al., 2009; Mayhew, Rockenbach, Seifert, Bowman, & Wolniak, 2016; Murray, 2017; Pascarella & Terenzini, 2005). Moreover, given changing demographics in undergraduate enrollments and calls for eliminating equity gaps in HIPs, it is crucial to acknowledge that UGR has long been hailed as important for racially minoritized student outcomes (Collins et al., 2017; Jones, Barlow, & Villarejo, 2010). Institutions should thus ensure racially minoritized students have access to and participate in UGR experiences that deliver on the promised outcomes.

HIPs such as UGR represent sound educational practices with positive outcomes, yet as Kuh and Kinzie (2018) cautioned, the quality of their implementation matters more than the label. Elements of quality in UGR, including high levels of student–faculty interaction, close mentoring and supervision, and substantive feedback about performance (Bauer & Bennett, 2008; Elgren & Hensel, 2006; Kuh & O'Donnell, 2013), must be emphasized for the experience to be truly high impact. In addition, participation gaps that exist across HIPs, particularly among historically underserved students in higher education (Finley & McNair, 2013; National Survey of Student Engagement [NSSE], 2018), reveal that UGR is falling short of equity goals. The twin concerns of quality and equity in UGR deserve persistent attention.

A key feature of UGR is the substantive interaction between students and faculty, usually described as mentorship or apprenticeship (Temple, Sibley, & Orr, 2019). Although there is a strong belief that this interaction is positive for both students and faculty, it is a faculty role that is devalued or underrecognized in the academy, and the practice is generally considered an extra-role behavior (DeAngelo, Mason, & Winters, 2016; Evans, 2010; Laursen, Seymour, & Hunter, 2012). Faculty face a range of institutional and departmental barriers in involving undergraduate students in research, including promotion and tenure systems that emphasize research productivity over engagement with and mentoring of undergraduate students (Eagan, Sharkness, Hurtado, Mosqueda, & Chang, 2011; O'Meara & Braskamp, 2005; Morrison et al., 2019). A demanding workload, a reward structure that fails to incentivize mentoring students, and scarce time to train undergraduates combine to make it less likely for faculty to engage in UGR. Any advances in UGR are dependent on faculty commitment to mentoring and, more so, department support and incentives that encourage faculty members to mentor undergraduate students through research experiences.

Given UGR's positive outcomes and widespread appeal, it would be a significant leap forward if more students, and particularly underrepresented students, had a greater opportunity to pursue undergraduate research and to work closely on this endeavor with faculty, peers, and other researchers whose dedication of time and instruction were supported and recognized. What information do we have that higher education is making progress on this transformative vision?

Tracking participation and identifying equity gaps in UGR are important mileposts for access to and equity in educationally beneficial experiences. Additional information about students' exposure to elements of quality in UGR and how this corresponds to faculty perspectives and instructional practice can help further inform efforts to advance and improve UGR. One source of information about issues of access, equity, and quality is the NSSE, an annual survey that assesses educational quality by asking students at hundreds of institutions about their participation in practices associated with learning and success, and the companion instrument, the Faculty Survey of Student Engagement (FSSE), which asks faculty to report on their experience with engaging educational practices. We used these data to explore the national landscape of UGR by examining students' participation over time, by institutional type and characteristics including gender, race-ethnicity, first-generation status, and other identities, and the importance faculty place on UGR by discipline. We present our findings and

also share results from supplemental questions added to NSSE to explore students' exposure to elements of good practice in UGR and to discuss issues of implementation quality.

Data and Measures

The findings presented here come from descriptive analyses of the NSSE and the complementary FSSE. We used data from the 2013–2019 administrations of the NSSE, which surveyed over 2 million 1st-year and senior respondents from over 1,300 four-year colleges and universities. The NSSE is an annual survey of undergraduates that focuses on the time and effort that students put into their studies and other educationally purposeful activities. It measures their participation in curricular and cocurricular activities, their interactions with faculty, the support they perceive from their institution, and their participation in HIPs such as UGR experiences. The NSSE and FSSE are administered online in the spring semester at participating institutions with survey invitations and reminders sent through email or, optionally, linked on learning management systems. In this study's most recent year of student data, 2019, 1.5 million 1st-year and senior students were invited to participate with an average institutional response rate of 28%; over 20,000 faculty were invited to participate with an average institutional response rate of 42%. NSSE and FSSE participating institutions are representative of the profile of institutions, faculty, and students at bachelor's-granting U.S. institutions (FSSE, 2019; NSSE, 2019a). The analyses presented here are not statistical in nature, focusing instead on differences in percentages within subgroups and across years of administration.

Student Data: NSSE

Specifically, the NSSE asks students whether they have done or plan to do *work with a faculty member on a research project* before they graduate. (Note that throughout this study, italicized words represent direct quotes from the survey questionnaires.) Responses include (a) *done or in progress*, (b) *plan to do*, (c) *do not plan to do*, and (d) *have not decided*. The NSSE's question about UGR approximately aligns with the Council on Undergraduate Research's (2018) definition of UGR as a collaborative enterprise between student and faculty member that fosters an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution. We focused on 1st-year students who planned to do UGR and seniors who had done or were in progress on their UGR experience, depicting participation by institutional type and a variety of student characteristics. The variables drawn from the NSSE should be considered categorical in nature with no significant recoding beyond collapsing some demographics to increase sample size; for example, we combined students who identified as bisexual, gay, lesbian, queer, questioning, or unsure about their sexual orientation into an LGBQ+ category. Within each year, the number of students within any subgroup studied here totaled over 1,000 except for students identifying as nonbinary or as Native Hawaiian or other Pacific Islander. In these subgroups, across administrations, the count of students ranged between 816 and 2,926 nonbinary students and between 710 and 997 Native Hawaiian or other Pacific Islander students. Note that we roughly use the term "nonbinary" to refer to students and faculty who did not identify with the options *man* or *woman* and instead chose *another gender identity*. We recognize that the nonbinary label is not perfectly descriptive of this population and only use it here as an oversimplified term for a complicated grouping of identity.

To explore dimensions of quality of students' experience in UGR, we present data from a special study in 2019 of the elements of HIP quality. The NSSE appended an additional item set to the end of the core survey at a representative random selection of 41 institutions asking students who had participated in one of the six HIPs measured on the NSSE a series of questions about their experience, such as their dedicated time and effort, meaningful interactions with faculty, and the

opportunities they had to reflect on, apply, and integrate aspects of their learning. The results presented here focus on students who had participated in a UGR experience and their interactions with faculty, a key component of UGR. These questions asked students, as part of their undergraduate research experience, how often (*very often*, *often*, *sometimes*, *never*) they met *with a faculty or staff member* from their institution. Of those who responded *sometimes* or more often, they were asked to what extent (*very much*, *quite a bit*, *some*, *very little*) these meetings focused on what students were *learning* as part of their UGR experience. This set also asked students how often they received *feedback* from a *faculty or staff member* at their institution, and of those that said more often than *never*, to what extent this feedback was *beneficial*. We also examined students' responses to *overall, how would you evaluate the quality of this experience* on a rating scale of 1 (*poor*) to 7 (*excellent*). We collapsed some of the categories of these variables as part of our analyses and indicate when we have done so alongside the findings.

Faculty Data: The FSSE

To complement our student perspectives, we present findings on the importance of and instructional practice in UGR with data from the NSSE's companion survey, the FSSE. We use data from the 2014–2019 administrations of the FSSE, a compilation of responses from over 106,000 faculty from 442 four-year colleges and universities. The FSSE is an annual survey of instructional staff focusing on their expectations and facilitation of student engagement in educational practices that have been empirically linked with student learning and development. It measures the frequency of their use of effective teaching practices, the nature and frequency of their interactions with students, how they organize their time both in and out of the classroom, and the importance they place on student participation in HIPs such as UGR. Specifically, the FSSE asks instructional staff to rate how important it is to them that the undergraduates at their institution *work with a faculty member on a research project* before they graduate with the responses (a) *very important*, (b) *important*, (c) *somewhat important*, and (d) *not important*. Additionally, the FSSE asks, in a typical 7-day week, if instructional staff participate in *working with undergraduates on research*, with responses of either (a) *yes* or (b) *no*. We focus on both questions to provide a faculty perspective on student participation in UGR in the findings presented here. We collapsed faculty responses to the importance of participation by combining *very important* and *important* as indicated with our findings.

Findings

Our presentation of descriptive statistics provides a national overview of UGR participation with a variety of salient institutional and student characteristics, a broad summary of faculty involvement in UGR, and baseline data about students' exposure to elements of high-impact UGR. In particular, the following section describes findings for student expectations for and participation in UGR over time by major and a variety of student characteristics, with a focus on underrepresented students across a range of diversity domains (parental education, gender identity, racial/ethnic identification, diagnosed disability, and sexual orientation). Additionally, we include student perspectives on their interactions with faculty using data from a 2019 special study of HIP quality. Finally, we complement our student view with faculty perspectives on the importance of and their instructional practice in UGR. Descriptive statistics for the aggregate as well as for student and faculty subpopulations highlight trends and general differences.

First-Year Expectations for UGR

Knowing whether 1st-year students plan to participate in UGR can reveal insights about students' expectations, their awareness of opportunities, and the clarity of institutional promotion about UGR. Such information might also raise more questions, including what contributes to students' expectations, if students' assumptions about who should participate in UGR influences their plans, or why some entering students are markedly undecided or have no plans to participate in UGR. These results might be particularly helpful at an institutional level, but they are also essential to examine given the rather widespread efforts to increase participation in UGR, to expand experiences beyond STEM majors, and in particular, to reduce equity gaps. While expectations are not a guarantee of future behavior, they have been shown to affect students' motivation, engagement, and investment of effort in learning (Konings, Brand-Gruwel, S., van Merrienboer, J. J. G., & Broers, 2008) and optimistic expectations are linked to higher accomplishment (Armor & Taylor, 1998; Schilling & Schilling, 2005). Therefore, we should be concerned about 1st-year students' plans, particularly if the students who express no plans to participate in UGR are from groups who are historically underrepresented in UGR.

We examined 1st-year expectations for participating in UGR by looking at the responses of 972,088 1st-year students who reported that they planned to do an UGR experience before they graduate. Over time, 1st-year plans to participate in UGR have remained relatively stable. Between 2013 and 2019, around one third, ranging from 32% to 35%, of 1st-year students overall planned to participate in UGR (Table 1). Differences among subgroups of students have little variation over time as well.

Table 1. Percentages of 1st-year students' UGR intentions over time by student and institutional characteristics.

Variable	Plan to do UGR (%, year)							Do not plan to do UGR (%, 2013–2019)
	2013	2014	2015	2016	2017	2018	2019	
Major field								
Arts & humanities	28.8	28.9	29.8	29.9	29.1	28.5	27.7	23.6
Bio sci, agric, & nat resrcs	53.0	54.6	55.5	55.3	56.3	56.4	55.2	10.1
Phys Sci, Math, & CS	45.2	46.5	46.0	43.8	44.9	44.1	42.5	14.0
Social sciences	40.0	42.3	42.5	42.7	42.0	43.0	41.7	16.2
Business	25.9	27.3	28.2	26.2	27.0	27.1	26.4	30.4
Comm, media, & PR	24.6	27.7	27.3	24.0	26.2	26.9	26.8	28.0
Education	20.6	23.0	22.5	21.0	22.2	22.3	20.7	32.9
Engineering	42.7	47.0	44.7	44.0	45.1	44.0	41.8	13.6
Health professions	26.3	29.6	29.9	29.3	28.9	29.6	29.4	28.2
Social service professions	27.0	28.5	31.6	29.3	30.5	31.7	30.3	25.7
Parental education								
First generation	30.4	33.4	33.5	32.9	33.4	32.4	31.9	24.1
Not first generation	33.6	36.0	35.7	34.9	36.1	36.4	34.6	22.2
Gender identity								

Variable	Plan to do UGR (%, year)							Do not plan to do UGR (%, 2013–2019)
	2013	2014	2015	2016	2017	2018	2019	
Another gender identity	--	37.9	32.9	31.1	35.2	35.9	36.3	20.4
Man	35.5	38.3	37.7	36.4	37.4	36.4	34.8	20.7
Woman	30.5	33.1	33.4	33.0	33.8	34.0	32.9	24.1
Racial/ethnic identification								
American Indian or Alaskan native	31.4	33.5	34.0	31.6	34.6	31.7	29.6	24.8
Asian	48.2	48.5	46.0	49.1	47.4	45.3	43.1	16.1
Black or African American	36.3	37.8	38.1	36.9	37.4	37.5	37.0	21.5
Hispanic or Latinx	35.5	38.9	38.4	36.9	36.4	36.5	35.7	20.9
Native Hawaiian or other Pacific Islander	38.0	37.1	34.2	34.6	39.6	34.6	31.2	22.7
White	29.6	31.9	32.1	31.3	32.4	32.4	31.3	24.6
MENA or another r/e	39.9	42.6	43.3	42.9	39.7	40.0	40.9	18.8
Multiracial	33.0	35.5	35.1	35.1	35.7	35.0	34.8	21.9
Diagnosed disability								
No	32.3	34.9	34.7	34.0	35.0	34.6	33.4	23.3
Yes	31.9	34.9	35.2	33.9	34.3	35.0	33.6	21.2
Sexual orientation								
LGBQ+	37.7	38.7	36.7	38.6	38.0	37.8	36.6	18.9
Straight	33.4	35.8	36.4	35.6	34.6	34.3	33.1	23.3
Basic Carnegie classification								
Doc/v high rsrch activity	37.4	41.1	39.3	40.1	41.4	42.3	37.2	20.6
Doc/high rsrch activity	35.1	37.4	37.0	35.6	37.9	35.8	35.6	22.1
Doc/professional U's	31.3	34.5	35.4	30.2	33.3	30.7	29.9	25.4
Master's C&U larger	28.3	30.6	32.3	30.6	31.2	31.7	31.7	25.4
Master's C&U medium	30.0	32.0	31.9	33.0	30.8	30.2	31.2	24.6
Master's C&U smaller	33.4	31.7	36.6	30.0	31.6	33.2	29.5	24.1
Bacc. arts & sciences focus	41.2	44.9	44.5	44.3	45.0	44.5	41.5	14.4
Bacc. diverse fields	29.2	28.9	30.0	29.7	29.1	29.9	31.0	26.1
Other Carnegie Categories	27.8	33.0	28.4	28.2	30.8	28.4	30.6	23.7
Institutional control								

Variable	Plan to do UGR (%, year)							Do not plan to do UGR (%, 2013–2019)
	2013	2014	2015	2016	2017	2018	2019	
Public	31.8	34.5	34.8	33.2	35.1	32.9	33.4	24.0
Private-not-for-profit	33.8	36.2	36.2	36.6	35.3	37.8	34.4	21.2
Private-for-profit	19.4	25.7	21.4	20.8	22.3	19.7	21.4	31.6
Institution size based on undergraduate enrollment								
Very small (< 1,000)	33.6	35.2	31.2	37.4	34.1	33.6	33.2	21.9
Small (1,000–2,499)	34.7	36.6	37.2	35.3	36.8	36.7	34.0	20.3
Medium (2,500–4,999)	32.7	35.4	33.8	34.6	34.4	33.3	32.8	22.8
Large (5,000–9,999)	31.2	31.9	35.2	32.9	33.4	36.1	33.7	23.8
Very large (10,000+)	31.5	35.6	34.9	33.9	35.5	34.2	33.7	24.0
Total percentage	32.3	34.9	34.9	34.2	35.1	34.7	33.6	23.1

Note. UGR = Undergraduate research; Bio sci =Biological science; Agric = agriculture; Nat resrcs = natural resources; Phys sci = physical sciences; CS = computer science; Comm = communications; PR = public relations.

Smaller differences. There are small differences between different subgroups (Table 1), for example, first-generation students planned to participate at slightly lower rates (around 32% over time) compared to their non-first-generation peers (around 35% over time). Men planned to participate at slightly higher rates (around 37%) than nonbinary students (around 35%) and women (around 33%). LGBQ+ students planned to participate in slightly greater proportions (around 38%) than straight students (around 35%). Notably, students with and without diagnosed disabilities planned to participate in roughly the same proportions (around 34%).

Larger differences. Slightly larger differences occur for participation over time by students' racial/ethnic identification (Table 1). Asian 1st-year students were proportionally the largest group planning to participate in UGR (around 47% over time), compared to around a third of students of other racial/ethnic identities planning to participate. The largest differences between student subgroups planning to participate in UGR appear within students' major fields. The largest proportions of students, near or over half of students within a major grouping, are in biological sciences, physical sciences, and engineering. Even major fields with smaller proportions of students planning to participate in UGR (such as education, communications, and business) saw around a quarter of their students with UGR aspirations.

Institutional differences. With respect to the institutions that students attended, there are no notable trends of change in students' aspirations to participate in UGR over time (Table 1). There is a noticeably higher proportion of 1st-year students planning to participate in UGR attending baccalaureate-granting institutions with an arts and sciences focus and a slightly higher proportion of such students at doctoral-granting institutions with very high research activity. Publicly and privately controlled institutions are fairly consistent with around one third of 1st-year students planning to participate in UGR, but private-for-profit institutions have a noticeably lower, around one in five,

proportion of such students. An institution's size did not seem to be related to students' plans to participate in UGR.

Senior Participation in UGR

An actual indicator of students' participation in UGR is found in seniors' NSSE results. Knowing which seniors have experienced UGR provides a solid measure of the extent to which UGR is a part of students' undergraduate education overall and how experiences are distributed across majors and institutional types. Again, participation data is important to track to examine issues of access and equity. Data over time can also help determine if the number of experiences is increasing given greater emphasis on experiential learning and UGR as valued educational practices.

We examined senior participation in UGR by looking at the responses of 1,248,854 senior students who reported that they had done or were currently involved in a UGR experience to be completed before they graduated. Over time, senior participation in UGR has similarly remained relatively stable. Between 2013 and 2019, around one quarter, ranging from 24% to 27%, of seniors overall participated in UGR (Table 2). Differences for other subgroups of students, however, are more noticeable for senior participation than they were for 1st-year plans to participate.

Table 2. Percentages of senior participation in UGR over time by student and institutional characteristics.

Variable	Participation in UGR (%, year)						
	2013	2014	2015	2016	2017	2018	2019
Major field							
Arts & humanities	28.6	29.9	29.7	30.0	27.9	28.4	27.2
Bio sci, agric, & nat resrcs	47.0	48.9	48.5	48.7	48.4	48.2	47.2
Phys sci, math, & CS	42.4	45.0	42.2	41.8	40.8	40.3	40.1
Social sciences	31.7	35.9	34.7	33.9	32.1	32.5	31.9
Business	12.5	14.2	13.1	13.2	11.7	11.7	11.5
Comm, media, & PR	23.9	23.1	23.6	22.9	21.5	21.4	23.2
Education	15.4	17.5	17.2	15.6	16.1	14.6	16.1
Engineering	31.4	35.7	31.8	32.8	31.5	31.5	32.4
Health professions	19.5	20.5	20.7	20.7	19.4	18.9	20.5
Social service professions	16.3	19.5	18.3	16.7	17.5	17.8	15.7
Parental education							
First generation	19.2	22.2	20.8	20.0	19.4	18.8	18.4
Not first generation	28.8	31.5	29.8	29.9	29.2	28.8	28.7
Gender identity							
Another gender identity	--	34.9	34.4	36.0	32.5	30.4	32.7
Man	24.5	28.6	26.1	25.4	24.6	23.7	23.0
Woman	24.0	26.5	25.2	25.3	24.6	24.3	24.5
Racial/ethnic identification							
American Indian or Alaskan native	21.9	24.7	24.4	21.1	19.5	20.1	18.2

Variable	Participation in UGR (%, year)						
	2013	2014	2015	2016	2017	2018	2019
Asian	25.8	25.3	24.7	26.3	23.9	25.4	24.0
Black or African American	17.9	21.5	20.3	20.5	19.7	18.7	19.4
Hispanic or Latinx	18.8	21.4	20.3	19.2	18.0	17.3	19.2
Native Hawaiian or other Pacific Islander	19.4	21.5	18.8	18.6	17.2	20.1	22.3
White	25.1	28.7	26.9	26.6	26.4	26.0	25.2
MENA or another r/e	24.1	26.9	24.5	26.1	24.1	24.1	26.3
Multiracial	26.5	29.0	26.8	27.8	26.9	25.5	26.1
Diagnosed disability							
No	24.3	27.3	25.5	25.3	24.4	23.9	23.7
Yes	23.8	28.1	26.5	26.8	27.3	26.0	26.4
Sexual orientation							
LGBQ+	31.9	34.4	32.8	33.8	32.2	31.9	32.7
Straight	24.4	28.3	26.3	27.1	24.0	23.4	23.1
Basic Carnegie classification							
Doc/v high rsrch activity	27.6	28.8	28.2	28.2	25.3	27.2	26.4
Doc/high rsrch activity	25.9	27.7	25.4	26.3	26.8	24.5	26.4
Doc/professional U's	17.5	23.8	23.7	17.0	19.1	16.3	17.4
Master's C&U larger	19.0	21.3	21.5	21.3	20.2	20.8	20.5
Master's C&U medium	23.9	25.9	26.9	26.5	25.8	24.3	25.8
Master's C&U smaller	28.8	29.6	28.4	25.8	25.5	24.6	26.4
Bacc. arts & sciences focus	45.8	47.8	45.9	46.8	47.9	45.5	44.3
Bacc. diverse fields	26.7	28.3	25.9	27.0	22.7	25.3	26.3
Other Carnegie categories	19.1	24.7	14.1	22.4	18.5	20.1	21.0
Institutional control							
Public	23.1	25.0	23.6	23.4	22.9	21.1	23.8
Private-not-for-profit	28.2	32.6	30.9	30.7	29.7	30.5	27.0
Private-for-profit	4.6	7.5	6.4	5.5	4.1	6.5	3.2
Institution size based on undergraduate enrollment							
Very small (< 1,000)	35.9	32.4	30.8	37.5	31.4	31.7	31.3
Small (1,000–2,499)	33.7	36.1	35.1	32.6	33.9	32.2	32.0
Medium (2,500–4,999)	27.3	31.5	27.1	28.9	27.8	25.9	26.6
Large (5,000-9,999)	24.3	24.6	23.5	23.3	22.7	23.5	23.3
Very large (10,000+)	20.2	23.6	23.1	22.0	21.3	20.6	21.1
Total	24.0	27.1	25.3	25.1	24.4	24.0	23.9

Note. UGR = Undergraduate research; Bio sci =Biological science; Agric = agriculture; Nat resrcs = natural resources; Phys sci = physical sciences; CS = computer science; Comm = communications; PR = public relations.

Smaller differences. Seniors with a diagnosed disability participated at nearly the same rate as students without a diagnosed disability, around 25% over time. Around a quarter of seniors identifying as Asian, White, or multiracial participated in UGR compared to around one in five students identifying as American Indian or Alaskan native, Black or African American, Hispanic or Latinx, and Native Hawaiian or other Pacific Islander (Table 2).

Larger differences. Around a third of LGBQ+ seniors participated in UGR compared to around a quarter of their straight peers. Similarly, around a third of seniors identifying with a nonbinary gender participated in UGR compared to around a quarter of seniors identifying as men or women. One of the largest observable differences is that around 20% of first-generation seniors over time participated in UGR compared to around 30% of non-first-generation students. Differences by major field are also striking with around 48% of biological science, 42% of physical science, and 32% of engineering seniors having participated in UGR compared to around 23% of communications, 20% of health professions, and 16% of education seniors (Table 2).

Institutional differences. Again, there are no notable trends in senior participation in UGR over time with respect to the institutions they attended (Table 2). But the differences in senior participation by institution type is markedly varied compared to differences in 1st-year anticipation to participate in UGR. Around one in five seniors participated in UGR at doctoral-granting professional institutions and master's-granting institutions with larger programs; comparatively, closer to half of seniors participated in UGR at baccalaureate-granting institutions with an arts and sciences focus. Seniors at privately controlled institutions participated at slightly higher rates than those at publicly controlled institutions, but seniors at those institutions participated far more than the 1 in 10 seniors who did so at private-for-profit institutions. There does seem to be an inverse relationship between senior participation in UGR and the size of the institution, with lower proportions of seniors participating as the institution increases in size. Around one in five seniors participated in UGR at institutions with over 10,000 undergraduates enrolled compared to around one in three at institutions with fewer than 1,000 students enrolled.

Looking within major fields. Looking within major fields, we find interesting differences in UGR participation by subgroups, such as gender identity. In some fields, such as biological sciences, health professions, and business, participation across gender identity is relatively stable. In other fields, such as physical sciences, social sciences, and engineering, women and nonbinary seniors participated at greater rates than men (Figure 1).

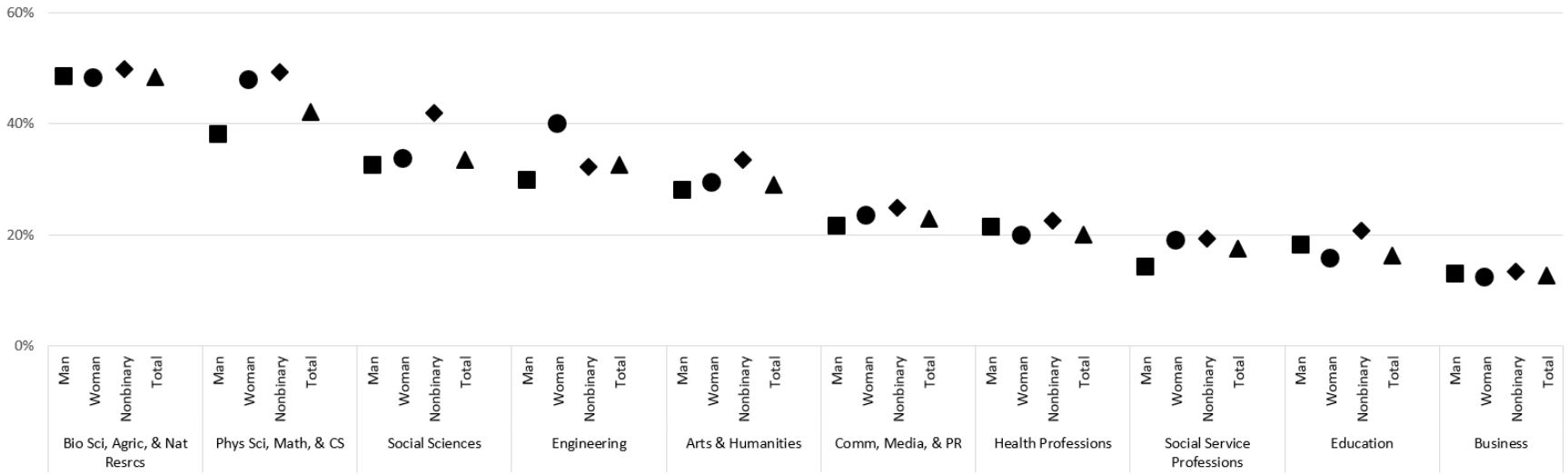

Figure 1. Senior undergraduate research participation by major field and gender identity. Bio sci =Biological science; Agric = agriculture; Nat resrcs = natural resources; Phys sci = physical sciences; CS = computer science; Comm = communications; PR = public relations.

Student Perspectives on Faculty Interaction and Quality

One of the cornerstone practices in UGR is apprenticeship, specifically, interaction with and feedback from a faculty member involved in the research experience. In our 2019 initial foray into the study of quality of undergraduate participation in HIPs (using a short item set appended to the NSSE survey at representative, random select institutions), 694 senior students answered additional questions about their experience participating in UGR. Four out of five (80.4%) frequently (*very often* or *often*) met with a faculty or staff member from their institution as part of their UGR experience. Of those who ever met with a faculty or staff member, 80.0% felt that these meetings substantially (*very much* or *quite a bit*) focused on what they were learning during their research experience. A similar proportion of these students (82.6%) frequently received feedback from a faculty or staff member at their institution during their UGR experience. Of those who ever received feedback, 88.1% felt that this feedback was substantially beneficial to them. Students' satisfaction with their UGR experience is also a vital measure of quality. Overall, on a 7-point scale of 1 (*poor*) to 7 (*excellent*), nearly all (93.2%) seniors evaluated the overall quality of their UGR experience as a 5, 6, or 7.

Faculty Perspectives on the Value of Undergraduate Research

The long-standing importance placed on faculty-mentored UGR and expectations for high levels of student–faculty interaction make it incumbent to explore what faculty value about UGR. We explored faculty perspectives on student participation in UGR by examining data from 106,859 faculty members responding to the FSSE. The value faculty place on students' participation in UGR has remained relatively stable over time, with about 60% viewing it as *very important* or *important*. However, there are differences by faculty discipline. The largest proportions (around 80%) of faculty with high values of importance for UGR were in biological sciences, physical sciences, and social sciences. Even fields with lower proportions of faculty who found it important for students to participate in UGR, such as around 40% of business faculty, still had a sizable proportion of faculty who supported UGR. Smaller proportions of faculty, however, participated in supervising undergraduate researchers, with a range of around 20% to 40% of faculty acting as research mentors.

Looking within disciplinary fields. In some fields, the gap between faculty values for participation and faculty participation in supervising is rather close, such as in health professions and education, with around half of faculty finding UGR important as well as half of faculty participating as supervisors. In other fields, however, the gap is quite large. In biological sciences, around 80% of faculty found it important for undergraduates to participate in UGR, but only around 40% acted as supervisors. Similarly, in physical sciences, around 70% of faculty found it important for undergraduates to participate, but only 20% supervised UGR (see Figure 2).

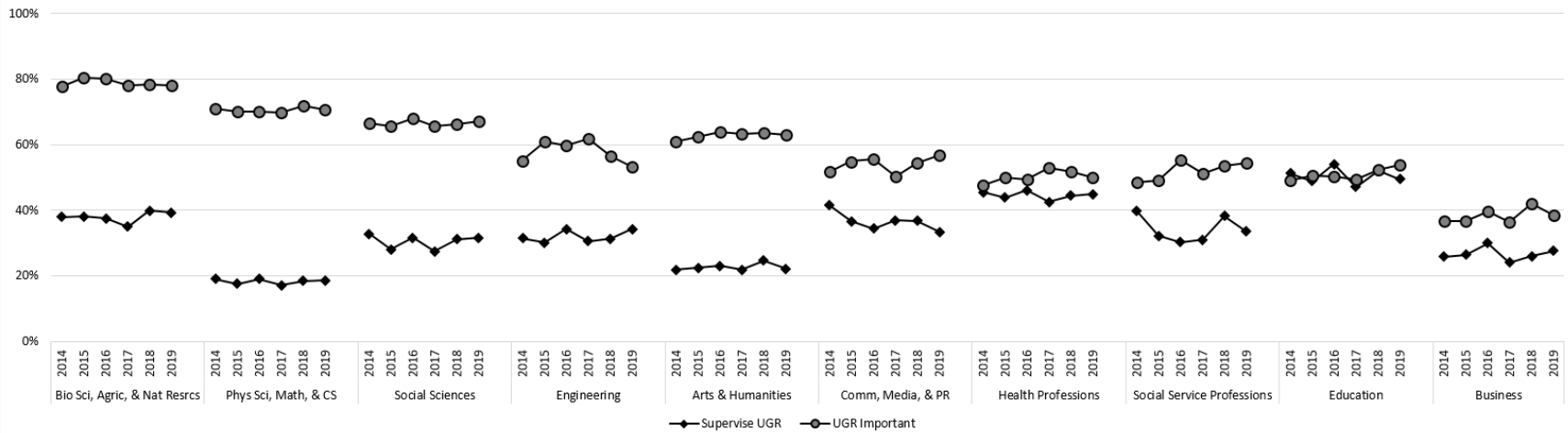

Figure 2. Faculty participation in and importance (*Very important* or *Important*) of undergraduate research (UGR) over time by disciplinary area. Bio sci =Biological science; Agric = agriculture; Nat resrcs = natural resources; Phys sci = physical sciences; CS = computer science; Comm = communications; PR = public relations.

Institutional differences. Faculty values and participation in UGR by institutional characteristics provide another perspective on student participation (Table 3). Around two thirds of faculty employed at baccalaureate-granting institutions with an arts and sciences focus found it important for undergraduates at their institution to participate in UGR, with slightly fewer, but still more than half, of faculty feeling the same at other institution types. A similar proportion at publicly and privately controlled institutions felt that UGR is important, and there is a small inverse relationship between institution size and faculty views of UGR importance. There are notable differences in faculty participation in UGR activities by institution type that parallel many of the finding for student participation. The largest proportions of faculty, around half, participated in UGR at baccalaureate-granting institutions with an arts and sciences focus. Slightly more faculty employed at publicly controlled institutions than private institutions participate in UGR, with about half as many faculty from private-for-profit institutions doing so. Unlike senior participation patterns, the relationship between participation in UGR and undergraduate enrollment size of the institution appears to be consistent, with around two in five faculty supervising undergraduates in research.

Table 3. Percentages of faculty importance and participation in UGR over time by institutional characteristics

Variable	Importance of UGR participation (%, year)							Faculty participation in UGR (%, year)						
	2014	2015	2016	2017	2018	2019	Total	2014	2015	2016	2017	2018	2019	Total
Basic Carnegie classification														
Doc/v high rsrch activity	59.6	60.5	57.8	59.4	61.3	59.6	59.8	49.5	41.6	42.5	42.3	42.9	38.8	43.0
Doc/high rsrch activity	59.6	57.4	58.5	56.0	57.9	59.8	58.1	50.7	43.4	43.8	38.2	44.8	40.2	42.8
Doc/professional U's	59.2	59.3	58.0	59.4	62.4	58.0	59.3	41.4	34.6	37.4	38.7	37.2	36.5	37.6
Master's C&U larger	56.6	57.6	56.7	55.0	58.7	56.8	56.8	38.8	36.5	35.9	35.3	38.7	34.2	36.6
Master's C&U medium	56.9	58.3	63.3	61.9	64.7	64.8	61.3	35.9	37.3	39.2	44.7	40.8	41.7	40.1
Master's C&U smaller	57.0	61.6	59.4	62.5	52.2	56.0	58.0	36.0	44.5	38.7	38.7	28.5	35.8	36.9
Bacc. arts & sciences focus	68.9	66.2	73.0	72.2	70.6	62.1	69.1	56.6	51.2	52.7	56.2	52.2	44.0	53.1
Bacc. diverse fields	56.5	58.5	59.9	59.1	59.9	64.6	59.4	39.1	36.5	35.1	39.1	32.8	40.6	37.2
Other Carnegie categories	55.4	53.2	52.0	52.4	54.7	50.3	53.4	33.2	26.8	28.0	27.3	26.3	24.1	28.4
Institutional control														
Public	57.3	59.9	57.8	58.7	60.3	60.0	59.0	42.6	40.9	39.5	40.6	41.3	40.3	40.9
Private-not-for-profit	60.3	58.5	60.8	60.8	59.7	57.8	59.6	40.9	37.0	36.6	39.4	35.9	32.8	37.2
Private-for-profit	45.6	39.0	--	42.3	--	--	42.2	21.7	16.9	--	18.9	--	--	19.1
Institution size based on undergraduate enrollment														
Very small (< 1,000)	64.7	59.3	65.7	61.8	58.3	63.0	62.3	44.5	40.1	37.9	40.0	33.0	39.6	39.3
Small (1,000–2,499)	57.6	59.8	59.0	64.8	58.4	59.6	59.8	39.7	38.1	35.8	44.8	34.4	34.4	38.2
Medium (2,500–4,999)	59.1	56.8	62.5	60.8	61.5	61.5	60.2	39.4	36.4	39.2	40.9	37.2	38.4	38.4
Large (5,000–9,999)	59.4	61.5	58.3	58.3	61.3	56.6	59.1	41.1	39.2	38.6	37.3	43.5	36.3	39.0
Very large (10,000+)	55.5	56.7	53.6	56.1	58.9	59.6	56.8	43.1	39.4	40.2	38.8	41.6	39.7	40.2

Note. URG = Undergraduate research.

Limitations

The large-scale nature of the results presented here gives us strong evidence for the generalizability of the trends in our findings. Even without inferential statistical analyses, it is easy to see notable trends within the descriptive statistics without examining the statistical significance that likely would appear given the large sample size of data. It is still important to note that the data examined here do not represent all types of institutions and obviously do not represent the voices of all students and faculty. But given the wide diversity in institutional, student, and faculty characteristics represented, the data present a strong case for the state of UGR in the United States over the last decade.

Because institutions participate somewhat regularly in the NSSE and FSSE, it is possible, albeit unlikely, that students and faculty are represented in the data more than once. The possibility of duplicate cases is decreased by the survey's cohort-based design with the construction of the data based on separate 1st-year and senior experiences and the common 3- or 4-year participation cycles of regular survey administration, but results should still be interpreted with this in mind. Additionally, although there is overlap in the participation of institutions administering the NSSE and FSSE, we did not limit the data to create findings based on matched responses of students and faculty at the same institutions. Again, our aim was to broadly document the state of UGR. Thus, results should not be interpreted from the perspective of students and faculty responding in the exact same context. Readers should instead consider each set of findings as a distinct part of an overall story on the general state of UGR.

Discussion and Implications

Several decades of collective promotion of UGR, including efforts by the Council on Undergraduate Research and the National Science Foundation, and more than a decade of attention to UGR as an HIP have helped shine a spotlight on UGR as a valuable undergraduate experience. Yet, despite avid interest in expanding UGR, our findings show very little change in students' plans to participate or actual participation rates over time both for the overall 1st-year and senior rates as well as among subgroups of students. Entering students' aspirations are consistently strong at about 34% expressing intent to do UGR. The statistic showing that about a quarter of students partake in UGR may seem reasonable given practical institutional limits on the supply of experiences, which are typically opt-in and selective. Aside from the dozen or so institutions in the country, including the College of Wooster, the Massachusetts Institute of Technology, Carnegie Mellon University, and Stanford, that have made UGR a required or expected experience, UGR is not widely available across major fields. This reality of participation and vague notion of opportunity might be disappointing to proponents of expanding UGR, and in particular to students in fields outside of STEM and from historically underrepresented populations.

Given that in 2019, only about 5% of 1st-year students had participated in UGR across all institutional types (NSSE, 2019b), the true promise of more research experiences for 1st-year students is still elusive, and promotion of course-based research experiences (Rodenbusch, Hernandez, Simmons, & Dolan, 2016) is still a rare experience. Even more, entering students' plans to participate in UGR varied considerably by major and racial identity groups. Across major fields, the highest expectations (consistently more than half) to participate in UGR were among biological science, agriculture, and natural resource majors, and the lowest proportion (only a fifth) in education majors. Variation by racial-ethnic identities is particularly noteworthy, because Asian and Black/African American students had the highest expectations for UGR at 43% and 37%, respectively. On the other hand, the proportions of entering students who reported no aspirations for participating in UGR are more even, showing that 22% of Black/African American students and 21% of Latinx students,

compared to the 23% average, had no interest in UGR (Table 1). Early expectations may help compel students to seek out UGR, while uncertainty or undecidedness may depress inquiries or dull students' attention to UGR opportunities.

The gap between entering students' aspirations and senior students' actual participation in UGR is concerning. In this case, many racially minoritized students entered with expectations to participate in UGR, yet it appears that the obstacles identified in research, including lack of awareness of opportunities, an unwelcoming or stereotyping environment, or a culture than inhibits beliefs about research competence, among others (Aikens et al., 2017; Haeger & Fresquez, 2016; Hurtado et al., 2009), got in the way of actualizing this interest. Our data demonstrate the persistence of such barriers and should prompt more intentional efforts to guide and ensure that racially minoritized students who enter with interest get connected to the UGR experience they seek. It also provides encouragement for the systematic dismantling of obstacles that undermine participation.

The UGR expectations of 1st-year students are a marker of future participation and ought to be a statistic for undergraduate programs and proponents of UGR to keep track of and attempt to directly influence. For example, institutional data showing that racially minoritized students and students in non-STEM majors are more inclined to report being undecided or that they do not plan to participate in UGR should drive efforts to reach out to these subpopulations. Organizations and institutions could design tailored messaging to introduce and target invitations, asking themselves (and more importantly, asking students they hope to attract) what would make UGR appealing. In addition, a simple gauge of the efficacy of institution-level academic year or summer programs, such as the University of Michigan's Undergraduate Research Opportunity Programs, or the Undergraduate Research Experiences at Small Colleges and Universities project to support UGR in Nebraska, could be to compare their entering students' expectations and actual participation numbers to our national findings. Are they making a difference in increasing expectations and actual participation, and what does this suggest about supporting such programs at more institutions?

Entering student expectations for UGR are an important leading indicator, but actual participation rates and differences among subgroups of students are even more important to measure and monitor. Indeed, differences in actual senior participation by subgroups of students are greater in magnitude than they were for 1st-year plans to participate. Although our study was not longitudinal, UGR participation rates were generally lower than plans to participate. Could this be a mismatch in expectations? Or is it evidence of barriers to entry? Interestingly, differences between students' aspirations by institution type were trivial, but there were very large differences in senior participation by institution type, indicating that this gap may widen more or less depending on the institutional characteristics, and perhaps on the support faculty receive to engage in UGR supervision. For example, expectations are about the same for 1st-year students regardless of institution size, but participation proportions lower noticeably for students at larger institutions (with a gap as large as 12%). This again may be a function of fewer opportunities for UGR at large research institutions, particularly those with large graduate student populations, or it could be that smaller, baccalaureate-granting institutions are more equipped to meet entering student demand and support faculty in their UGR instructional roles.

More concerning are the gaps between the overall participation rate for historically underrepresented groups, including Black/African American, Latinx, Alaskan native, American Indian, Native Hawaiian, and Pacific Islander students. The combination of gaps in entering expectations for UGR and participation for racial-ethnic minoritized student groups is an alarm bell that has been ringing for a while in our data and has been raised as a concern in others' research (Collins et al., 2016; Haeger & Fresquez, 2016; Hernandez et al., 2018). Given the wealth of evidence showing the positive association between UGR and outcomes for minoritized students, we must use expectations data and participation rates to signal, measure, and address where we are falling short.

The 10% difference in UGR participation rates between first-generation and non-first-generation students is particularly troubling. Is it that students who are first in their family to attend college lack the social or cultural capital to know that UGR is an experience worth doing? Or is UGR something that students need to see firsthand? Do they need to know someone who has had this experience to seek it out? Or is UGR simply off-putting? Funding and stipends might help emphasize value and make the experience affordable and possible for first-generation students. Indeed, UGR is substantially different from the kind of learning experiences most students have been socialized to expect throughout their lives, and first-generation students might be most unfamiliar with the idea of UGR and the difference it can make as a transformative experience. The finding about first-generation students' lower rates of UGR participation might be a theme that first-generation student programs take up to help colleges and universities redesign UGR to be more inviting to and inclusive of first-generation college students. For example, the University of North Carolina Chapel Hill's "Carolina Firsts" program creates a sense of community for first-generation college students through a broad framework that encourages students to explore opportunities they would not normally seek, helps connect them with faculty and staff, and celebrates their unique contributions. Orientation programs featuring first-generation student success stories in UGR, personal outreach from peers, and advising and mentoring from first-generation faculty could encourage first-generation students to participate in UGR. Yet programs must be designed and assessed with institutional context in mind. As Whitley, Benson, and Wesaw (2018) documented, while some colleges and universities are having success increasing first-generation students' participation in HIPs, including UGR, uncertainties about resources and limited opportunities continue to constrain inclusion.

Key features in all definitions of UGR are the inclusion of apprenticeships and one-on-one interaction with faculty (Crisp & Cruz, 2009). The frequency of faculty mentoring through interaction and feedback and the extent to which this facilitates learning and helps students develop identities as scholars and skills in research are important and worth assessing. Our preliminary study to examine quality in UGR showed that 80% of seniors frequently met with a faculty or staff member from their institution as part of their UGR experience. Clearly UGR is imposing this key element. Even more important, students indicated that their meetings with faculty or staff members were substantively focused on what they were learning during their research experience and that they were receiving regular feedback about their performance. Combined with students' positive evaluation of their UGR experience, this adds confirmation of the value of this practice in undergraduate education. It is worth noting that while this initial study does not allow us to disaggregate results, a larger research project at the NSSE to examine elements of quality among racially minoritized students is underway.

Overwhelmingly, faculty who get involved in instructing and mentoring UGR feel that the research experience is good for students (Council on Undergraduate Research, 2010). Our findings about faculty perspectives on UGR confirm this, in that most faculty believed UGR is important for students. In fact, three quarters of faculty in this study who supervised undergraduate experiences found it important compared to closer to half of faculty who did not supervise UGR. The greatest differences among faculty are associated with discipline; for example, more faculty in biological sciences, physical sciences, and social sciences believed UGR is important for students to do compared to faculty in business. The extent to which faculty value UGR is important to measure and monitor, given its influence on student behavior. In other words, increases in UGR for students is dependent on faculty valuing the experience and then, of course, delivering effective instruction.

Among faculty across all disciplines, UGR importance exceeded actual practice. Faculty may be of one mind that students should do UGR, but there is a mismatch between this hope for student experience and what faculty can deliver. Lower levels of faculty participation in UGR mirror senior participation, which makes sense from a supply/demand perspective. Notably, a few disciplines—health professions, education, and business—had little to no gap between the importance faculty

attach to UGR and their supervision of students. However, biological sciences, physical sciences, social sciences, engineering, and arts and humanities all had significant gaps. The gaps point to potential sites for delivering more UGR for students. Faculty are inclined but are not able to supply.

Scholarship about faculty and UGR sheds light on the yawning gap between valuing UGR and faculty capacity to engage students in the experience. As Eagan et al. (2011) demonstrated, faculty face significant barriers to working with students in UGR experiences, including a heavy workload, a reward structure that does not incentivize mentoring students, limited funding, and the daunting amount of time required to mentor and train undergraduate researchers. Scholars consistently have found that given the many demands placed upon faculty, mentoring in UGR is challenging (Harvey & Thompson, 2009). Even though UGR is more demanding for faculty because undergraduates likely need more assistance to get acquainted with research expectations and skills, the experience becomes more enjoyable as students gain independence and confidence, and faculty receive gratification associated with bringing students into the research fold (Barker, 2009; Henderson et al., 2011). Our results illustrating the large gaps between faculty values and practice in certain fields deserve attention. What new strategies and delivery methods could increase their involvement? Results exposing the gap between faculty value and involvement combined with student expectations and actual participation could make a strong case for expanding conceptions about how to integrate UGR through short-term, course-based and scaffolded models with attention to disciplinary interests and needs.

Many colleges and universities today are advancing efforts to increase equity and inclusion and, in particular, to ensure vital HIPs such as UGR are equitable and of high quality (Association of American Colleges & Universities, 2018; Landrieu, Shah & Robertson, 2020). Creating an inclusive environment so all students find UGR welcoming, disaggregating participation data to explore equity gaps, and ensuring that historically underrepresented students experience mentoring are strategies for increasing equity in UGR (Finley & McNair, 2013; Hurtado et al., 2009). In an inclusive environment, student engagement in UGR should not be contingent on a student being specially selected or stumbling onto the opportunity; rather, these vital experiences should be critically examined for equity, and student involvement should be assured. In addition, UGR should be imbued with the elements of mentoring and substantive interaction with faculty that make it so special. Our preliminary evidence suggests that faculty are delivering on this dimension of the experience to a high degree. This is heartening evidence to demonstrate that faculty deserve to be rewarded for the high-quality experiences they are providing.

Equity is also a consideration for faculty supervising UGR. Faculty play a significant role in facilitating UGR, particularly in institutions where formal structured programs do not exist. Yet, absent tangible incentives to support UGR experiences, faculty may opt out of involving students and leave the difficult work of expanding access to those faculty who feel strongly about mentoring. Creating institutional incentives for faculty to work with undergraduates on research will reward those faculty who already support UGR and also provide motivation for others to engage in the experience. For institutions to develop and sustain UGR programs, they need the support of their faculty. Institutions also need to support their faculty, particularly faculty of color who are asked or encouraged to take on disproportionate labor in supporting racially minoritized students in UGR. Mentoring takes a particular emotional toll and professional cost for faculty of color (Schwartz, 2012) and institutions must prioritize their needs and support to increase the desired UGR student experiences.

Ensuring that more students partake in and benefit from engaging and applied experiences in undergraduate education is a national imperative. UGR represents a long-standing, valued HIP that contributes to many desirable learning and success outcomes, including sharpening students' skills and development for graduate education, for the workplace, and as citizens. However, the success and expansion of UGR require attention to increasing access and equity and assuring quality experiences. They are also highly dependent on faculty engagement, specifically their interest in and capacity for

mentoring students in UGR. This study provides evidence of these dimensions to take stock of and to inform efforts to increase and improve UGR.

References

Aikens, M. L., Robertson, M. M., Sadselia, S., Watkins, K., Evans, M., Runyon, C. R., ... Dolan, E. L. (2017). Race and gender differences in undergraduate research mentoring structures and research outcomes. *CBE—Life Sciences Education, 16*(2), ar34. https://doi.org/10.1187/cbe.16-07-0211

Armor, D. A., & Taylor, S. E. (1998). Situated optimism: Specific outcome expectancies and self-regulation. *Advances in Experimental Social Psychology, 30*, 309–379. https://doi.org/10.1016/S0065-2601(08)60386-X

Association of American Colleges & Universities. (2018). *A vision for equity: Results from AAC&U's project "Committing to Equity and Inclusive Excellence: Campus-Based Strategies for Student Success."* Washington DC: Author.

Barker, L. (2009). Student and faculty perceptions of undergraduate research experiences in computing. *ACM Transactions on Computing Education, 9*(1), Article 5. http://doi.acm.org/10.1145/1513593.1513598

Bauer, K. W., & Bennett, J. S. (2008). Evaluation of the undergraduate research program at the University of Delaware: A multifaceted design. In R. Taraban & R. L. Blanton (Eds.), *Creating effective undergraduate research programs in science: The transformation from student to scientist*. New York, NY: Teachers College Press.

Bhattacharyya, P., Chan, C., & Waraczynski, M. (2018). How novice researchers see themselves grow. *International Journal for the Scholarship of Teaching and Learning. 12*, Article 3. https://doi.org/10.20429/ijsotl.2018.120203

Boyd, M., & Wesemann, J. (Eds.). (2009). *Broadening participation in undergraduate research.* Washington DC: Council on Undergraduate Research.

Collins, T. W., Grineski, S. E., Shenberger, J., Morales, X., Morera, O. F., & Echegoyen, L. E. (2017). Undergraduate research participation is associated with improved student outcomes at a Hispanic-serving institution. *Journal of College Student Development, 58*(4), 583–600. https://dx.doi.org/10.1353%2Fcsd.2017.0044

Council on Undergraduate Research. (2010). How UR supports faculty & student development [Issue]. *Council on Undergraduate Research Quarterly, 31*(1), 1–50.

Council on Undergraduate Research. (2018). *Our organization.* Retrieved from https://www.cur.org/about_cur/#

Crisp, G., & Cruz, I. (2009). Mentoring college students: A critical review of the literature between 1990 and 2007. *Research in Higher Education, 50*(6), 525–545. https://doi.org/10.1007/s11162-009-9130-2

DeAngelo, L., Mason, J. & Winters, D. (2016). Faculty engagement in mentoring undergraduate students: How institutional environments regulate and promote extra-role behavior. *Innovative Higher Education, 41*(4), 317–332. https://doi.org/10.1007/s10755-015-9350-7

Eagan, M. K., Jr., Hurtado, S., Chang, M. J., Garcia, G. A., Herrera, F. A., & Garibay, J. C. (2013). Making a difference in science education: The impact of undergraduate research programs. *American Educational Research Journal, 50*(4), 683–713. https://doi.org/10.3102/0002831213482038

Eagen, M. K., Sharkness, J., Hurtado, S., Mosqueda, C. M., & Chang, M. T. (2011). Engaging undergraduates in science research: Not just about faculty willingness. *Research in Higher Education, 52*(2), 151–177. https://dx.doi.org/10.1007%2Fs11162-010-9189-9

Elgren, T., & Hensel, N. (2006). Undergraduate research experiences: Synergies between scholarship and teaching. *Peer Review, 8*(1), 4-7.

Faculty Survey of Student Engagement. (2019). FSSE 2019 overview. https://nsse.indiana.edu/fsse/findings-data-reports/fsse-overview/index.html

Finley, A., & McNair, T. (2013). *Assessing underserved students' engagement in high-impact practices*. Washington, DC: Association of American Colleges and Universities.

Haeger, H., & Fresquez, C. (2016). Mentoring for inclusion: The impact of mentoring on undergraduate researchers in the sciences. *CBE—Life Sciences Education, 15*(3), ar36. https://doi.org/10.1187/cbe.16-01-0016

Harvey, L., & Thompson, K. (2009). Approaches to undergraduate research and their practical impact on faculty productivity in the natural sciences. *Journal of College Science Teaching*, *38*(5), 12–13.

Henderson, C., Beach, A., & Finkelstein, N. (2011). Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature. *Journal of Research in Science Teaching, 48*(8), 952–984. https://doi.org/10.1002/tea.20439

Hernandez, P. R., Woodcock, A., Estrada, M., & Schultz, P. W. (2018). Undergraduate research experiences broaden diversity in the scientific workforce. *BioScience, 68*(3), 204–211. https://doi.org/10.1093/biosci/bix163

Hunter, A. B., Laursen, S. L., & Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 91*, 36–74. https://doi.org/10.1002/sce.20173

Jones, M. T., Barlow, A. E. L., & Villarejo, M. (2010). Importance of undergraduate research for minority persistence and achievement in Biology. *The Journal of Higher Education, 81*(1), 82–115. https://doi.org/10.1080/00221546.2010.11778971

Kilgo, C. A., Ezell Sheets, J. K., & Pascarella, E. T. (2015). The link between high-impact practices and student learning: Some longitudinal evidence. *Higher Education, 69*(4), 509–525. https://doi.org/10.1007/s10734-014-9788-z

Kinkead, J. (2003). *Valuing and supporting undergraduate research*. San Francisco, CA: Jossey-Bass.

Konings, K. D., Brand-Gruwel, S., van Merrienboer, J. J. G., & Broers, N. J. (2008). Does a new learning environment come up to students' expectations? A longitudinal study. *Journal of Educational Psychology, 100*(3), 535–548. https://doi.org/10.1037/0022-0663.100.3.535

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter*. Washington, DC: Association of American Colleges and Universities.

Kuh, G. D., & Kinzie, J. (2018, May 1). What really makes a 'high-impact' practice high impact? *Inside Higher Education*. https://www.insidehighered.com/views/2018/05/01/kuh-and-kinzie-respond-essay-questioning-high-impact-practices-opinion

Kuh, G. D., & O'Donnell, K. (2013). *Ensuring quality & taking high-impact practices to scale*. Washington, DC: Association of American Colleges and Universities.

Landrieu, J., Shah, P., & Robertson, T. (2020). Equity by design campus toolkit. Saint Paul, MN: Office of Equity and Inclusion, Minnesota State University.

Laursen, S., Seymour, E., & Hunter, A. B. (2012). Learning, teaching and scholarship: Fundamental tensions of undergraduate research. *Change: The Magazine of Higher Learning, 44*(2), 30–37. https://doi.org/10.1080/00091383.2012.655217

Lopatto, D. (2010). Undergraduate research as a high-impact student experience. *Peer Review, 12*(2). https://www.aacu.org/publications-research/periodicals/undergraduate-research-high-impact-student-experience

Mayhew, M. J., Rockenbach, A. B., Seifert, T. A., Bowman, N. A., & Wolniak, G. C. (2016). *How college affects students: A third decade of research*. San Francisco, CA: Jossey-Bass.

Morrison, J. A., Barthell, J. F., Boettcher, A., Bowne, D., Nixon, C., Resendes, K. K., & Strauss-Soukup, J. (2019). *Recognizing and valuing the mentoring of undergraduate research, scholarship, and creative activity by faculty members: Workload, tenure, promotion, and award systems* (CUR White Paper No. 2). Washington, DC: Council on Undergraduate Research.

Murray, J. L. (2017). *Undergraduate research for student engagement and learning.* New York, NY: Taylor & Francis. https://doi.org/10.4324/9781315692159

National Survey of Student Engagement. (2018). *Engagement insights: Survey findings on the quality of undergraduate education—Annual results 2018*. https://nsse.indiana.edu/research/annual-results/past-annual-results/nsse-annual-results-2018.html

National Survey of Student Engagement. (2019a). *NSSE 2019 overview*. https://nsse.indiana.edu/nsse/reports-data/nsse-overview.html

National Survey of Student Engagement. (2019b). *NSSE 2019 U.S. summary frequencies by Carnegie classification*. https://nsse.indiana.edu/html/summary_tables.cfm

O'Meara, K. A., & Braskamp, L. (2005). Aligning faculty reward systems and development to promote faculty and student growth. *NASPA Journal, 42*(2), 223–240. https://www.tandfonline.com/doi/abs/10.2202/1949-6605.1474

Pascarella, E. T., & Terenzini, P. T. (2005). *How college affects students: A third decade of research* (Vol. 2). San Francisco, CA: Jossey-Bass.

Rodenbusch, S. E., Hernandez, P. R., Simmons, S. L., & Dolan, E. L. (2016). Early engagement in course-based research increases graduation rates and completion of science, engineering, and mathematics degrees. *CBE—Life Sciences Education, 15*(2), ar20. https://doi.org/10.1187/cbe.16-03-0117

Schilling, K. M., & Schilling, K. L. (2005). Expectations and performance. In M. L. Upcraft, J. Gardner, & B. Barefoot (Eds.), *Challenging and supporting the first-year student: A handbook for improving the first year of college*. San Francisco, CA: Jossey-Bass.

Schwartz, J. (2012). Faculty as undergraduate research mentors for students of color: Taking into account the costs. *Science Education*, *96*, 527–542. https://doi.org/10.1002/sce.21004

Temple, L., Sibley, T. Q., & Orr, A. J. (Eds.). (2019). *How to mentor undergraduate researchers*. Washington, DC: Council on Undergraduate Research.

Weaver, G. C., Burgess, W. D., Childress, A. L., & Slakey, L. (Eds.). (2016). *Transforming institutions: Undergraduate STEM education for the 21st century*. West Lafayette, IN: Purdue University Press.

Webber, K. L., Nelson Laird, T. F., & BrckaLorenz, A. M. (2013). Student and faculty member engagement in undergraduate research. *Research in Higher Education*, *54*(2), 227–249. https://doi.org/10.1007/s11162-012-9280-5

Whitley, S. E., Benson, G., & Wesaw, A. (2018). *First-generation student success: A landscape analysis of programs and services at four-year institutions*. Washington, DC: Center for First-Generation Student Success, NASPA–Student Affairs Administrators in Higher Education, and Entangled Solutions.