JoSoTL
Journal of the Scholarship of Teaching and Learning

Volume 21, Special Issue, April 2021
josotl.indiana.edu

JoSoTL
Journal of the Scholarship of Teaching and Learning

Volume 21 | Special Issue | April 2021

JoSoTL
Journal of the Scholarship of Teaching and Learning

Volume 21	Special Issue	April 2021

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 1-2.
doi: 10.14434/josotl.v21i1.32463

Note from the Guest Editors

Sara Evans
Kennesaw State University
sevan120@kennesaw.edu

Jocelyn Evans
University of West Florida

Kristi Wilkum
University of Wisconsin Oshkosh

It has been our pleasure to bring together scholarship and stories of impact from teacher/scholars throughout the academy who engage their students in undergraduate research (UGR). This special issue reveals the diverse educational settings across the college campus and institutional types where UGR takes place. We have learned from our colleagues at community colleges how much the introduction of applied research early in an undergraduate's experience can set a student on a path for academic success and lifelong curiosity. From our colleagues at research-intensive institutions, we have learned how sophisticated models of peer mentorship can provide scaffolded opportunities for professional development and personal growth.

We are greatly indebted to the professional network provided by the High-Impact Educational Practices (HIPs) in the States Conference grown from the dedicated work of HIP champions such as George Kuh, Ken O'Donnell, Jerry Daday, and others on the program committee each year for the conference. The interdisciplinarity and accessibility of this conference has provided us with so much food for thought and so many wonderful connections. We also thank the editors of the *Journal of the Scholarship of Teaching and Learning* for entrusting to us this special issue. This collection provides a place for highlighting the truly notable efforts of faculty and administrators around the country on undergraduate research.

If you are reading this issue, it is likely that you already appreciate the value of UGR. It has a long history in many disciplines, but these projects have not always been conceptualized or designed with the strategies of HIPs in mind. In the past decade, higher education has seen a huge increase in the development of HIPs in areas such as UGR. Many of us who have been working on UGR know that the practice has outpaced the scholarship on pedagogy. Most of the empirical research on the benefits, implementation, and other outcomes associated with UGR has been conducted in the natural sciences. As social scientists in colleges that also include the arts and humanities, we often find ourselves speaking to the portability of UGR within the liberal arts classroom. We speak on behalf of the creatives, and fight for inclusive space on our campuses for celebrating the scholarly and creative activities of all our faculty and students. This special issue reflects and amplifies that effort. It is part of a growing body of scholarship that includes voices from a variety of disciplines, and explicitly includes projects that utilize HIP frameworks for UGR projects.

This work, at its core, is about engaging and retaining students. As teachers/scholars, we want our students to succeed in their academic endeavors, but also gain skills that will help them succeed with their future careers and lives. Without solid empirical evidence regarding what works well and what doesn't, we cannot advance the scholarship of teaching and learning related to UGR pedagogy.

To that end, we hope the articles in this issue provide new information and strategies that can be used in your own work and highlight emerging areas of inquiry. The articles illustrate some of the major areas of research related to UGR as a HIP in recent years. This includes highlighting issues relevant for the population served - that of the students, such as the importance of mentoring and the consideration of equity and inclusion in UGR. Some of the contributions to this issue treat access in holistic terms. UGR can benefit students through courses from cornerstone to capstone and can benefit them either within their major or throughout their overall academic experience. Other authors focus on subjects more relevant to the faculty experience and academic program development, such as: the assessment of UGR and communicating impact, strategies for embedding UGR across the curriculum, and the benefits of communities of practice. They point to the importance of scaling UGR, moving beyond one assignment in one class to a culture of UGR across the institution. The observations of our authors identify exciting future directions for scholarship on UGR as high impact practice. Lastly, the issue includes a section entitled "Stories of Impact", in which authors have shared narrative remarks (many including student voices) of the true lasting impact of UGR projects.

May this issue give you new ideas and perspectives on your own work with UGR. It begins with a piece by one of the leading minds on high impact practice, Ken O'Donnell, Vice Provost at California State University-Dominguez Hills. In addition to being one of the founders of the HIPs in the States Conference, O'Donnell is a prominent scholar in the area of HIPs. O'Donnell has addressed numerous conferences and workshops around the country on the intersections between deep learning and student success, the benefits of locating college learning in real world contexts, and the role of public state systems in educational reform.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 3-7.
doi: 10.14434/josotl.v21i1.32464

Good for What Ails Us

Ken O'Donnell
California State University-Dominguez Hills
kodonnell5@csudh.edu

Why a whole issue of JoSoTL for undergraduate research? We've known it's good for us for at least 25 years and depending on how you define it, more like 2,500. Weren't Plato and Socrates doing this?

Yes, but they didn't have to deal with fickle enrollments, impatient trustees, and credit hour regulations, which could drive anyone to hemlock. In the time since then - in fact, just in the time since many of us were in college ourselves - higher education has faced new crises that challenge our ability to sustain undergraduate research. For one, there's the explosion of student debt; nine years ago, the total for U.S. college students crossed a *trillion* dollars total, and since then it's added nearly a trillion more. This makes it hard to defend anything that looks pricey, or boutique.

More troubling than the cost of higher education is the social injustice. Like other high-impact practices, undergraduate research has a bad track record for equity. Students from historically underserved populations - ethnic and racial minorities, first generation, and Federal Pell Grant eligible - have enjoyed disproportionate benefits from experiences like learning communities, service learning, and research with faculty, but they've also been less likely to participate.

As shown in this volume's deep analysis of National Survey of Student Engagement (NSSE) and Faculty Survey of Student Engagement (FSSE) data by Jillian Kinzie and Allison BrckaLorenz, "Undergraduate Research as a Hallmark High-Impact Practice," the problems of inequity continue. "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 et al, 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."

So, expensive, hard to scale, and stubbornly prone to the perpetuation of racism and classism. This has been the rap against higher education in general, and HIPs like undergraduate research in particular. The opening piece in this special issue tells us - alarmingly - that the charges still stick.

Yet the readers of JoSoTL know perfectly well that undergraduate research is a good thing, and many of us have led workshops on it. Where we need help is in making it more equitable, more scalable, and then making the benefits so transparent that even our external stakeholders insist on getting more. The findings from Kinzie and BrckaLorenz provide a clear, up-to-the-minute diagnosis, showing down to the disciplines and demographic groups exactly where we need to do better.

To that diagnosis, the rest of the issue presents potential therapies. These benefit from some serious scholarship and research methodologies, applied over a decade or two of work across our institutions. With help from organizations like the Council for Undergraduate Research, the National Science Foundation, the National Institutes of Health, and the Association of American Colleges and Universities, faculty have been sharing ways to put research experiences earlier in the curriculum, into higher enrolled courses that serve a broader spectrum of students. The College Board has played an important role too, creating new Advanced Placement courses called Capstone and Research that emphasize innovation over rote memory, skills over content.

And the result, as this special issue demonstrates, is that both our incoming students and our new faculty are readier than ever to recast undergraduate research as the means to today's most urgently sought-after ends, namely equity, affordability, and quality.

Equity

In "Creating More Inclusive Research Environments for Undergraduates," Heather Haeger and her colleagues at California State University, Monterey Bay, begin with a crucial gap identified by Kinzie and BrckaLorenz, looking at students who seem to plan for research experiences but then don't follow through. The university's longtime support for undergraduate research is a model for the rest of the California State system, and shows that ethnic and racial gaps can indeed be closed with sustained attention, and a nuanced sense of inclusiveness not as a binary condition, but as a continuum. But they haven't solved it all: "Despite the success of these efforts, transfer students were still less likely to engage in research and a significant population of students believe that research would benefit them in their education and career goals, but are not able to participate. These findings point to the need for the creation of more opportunities and stronger outreach to lower-division, community college and recent transfer students."

That's a lapse addressed head-on in "Undergraduate Research Communities for Transfer Students: A retention model based on factors that most influence student success." Donna Chamely-Wilk and her colleagues at Florida Atlantic University and elsewhere describe a long-term, consortial approach for STEM retention that relies on research experiences that begin at community colleges and then continue at the universities. The key, they found, was peer support and mentorship, a theme developed extensively in "Mentored Research: Increasing the Reach of a High-Impact Practice" by Jenni L. Redifer, Derick Strode, and Cathleen Webb. The program design they call *tiered mentoring* shows how student collaboration across class standings, and in fact down to high school, improves participation rates for first-generation college students.

Judging from this volume, that willingness to experiment with radical redesign may be most important of all. The article titled "Supporting Biomedical Research Training for Historically Underrepresented Undergraduates Using Interprofessional, Nonformal Education Structures" delights in throwing out assumptions. What the authors call enrichment took different forms at different participating institutions, but share a handful of common characteristics like peer mentorship, reflection, and an emphasis on non-formal, low stakes interaction. Community colleges and universities participated equally in the experimentation, facilitated by the large-scale, consortial approach of a major National Institutes of Health (NIH) grant.

Readers who don't have access to a BUILD warchest as referenced in the article can start smaller, but will still clearly benefit from a willingness to mix things up. See in particular "Undergraduate Research as System: Mapping the Institutional Landscape of a High Impact Practice" by Laura E. Cruz and colleagues from Penn State University and University of Southern Indiana, which shows how rigorous system mapping at even a single institution can reveal gaps and misapprehensions about undergraduate research. At an even smaller scale, Kevin Clark and his colleagues at Indiana University Kokomo show in "Undergraduate Research Across the Psychology Curriculum: A Case Study and Program Assessment" the difference we can make with the introduction of just one course.

Affordability

This special edition of JoSoTL shows a couple of ways undergraduate research can address higher education's crisis of affordability, while beating its own reputation as too expensive to sustain at scale. The first, and more intuitive, argument is in course-based undergraduate research experiences (CUREs).

In "Undergraduate Research Embedded Across Course Levels and Types Through Scaffolded Projects," Sara Z. Evans and Jocelyn Evans investigate the effects of "embedding undergraduate research in courses across a variety of formats: a freshman interdisciplinary honors course, two different special topics courses in criminal justice made up of 5-15 undergraduate students focused on testing criminological, multiple directed study projects with graduate students, and a 30-40 person upper-level criminology research methods course." If we're going to beat the related problems of scale and affordability, this will be how. They open with a candid account of the obstacles of such embedding, commenting on the demands added to faculty workload. But by incorporating CUREs through such a range of disciplines, class levels, and section sizes, they provide ample evidence it can be done.

Those with more modest aspirations - or just less institutional pull - might start with CUREs by looking at Kathy Ritchie's article "Using Institutional Review Board (IRB) Protocols to Teach Ethical Principles for Research and Everyday Life: A High Impact Practice." She found that the simple, elegant addition of Institutional Review Board protocols added a measurable layer of research-related gains to her courses - not just in terms of persistence and completion, but of deep learning. "The IRB process could incite frustration and stress to students who are on a timetable and have not experienced such a sometimes legalistic, negotiated process of decision making and professional correspondence. However, these types of decision-making processes are common in professional settings and using the IRB process to mentor students may lead to a better understanding of working with teams and other professional groups, giving them insight into how to effectively navigate such professional dilemmas, as well as a way to sharpen professional demeanors and communication skills." This is powerful, portable learning, on the cheap.

The second angle on affordability depends on understanding a primary cause of student debt defaults, which is attrition. In its 2018 study on student debt default, the Brookings Institution found that excluding the for-profit sector, the default rate on student loans *tripled* for non-completers, 15% versus 5% for those who graduate (Scott-Clayton, 2018). Completers have better financial acumen, higher paying jobs, and the momentum and self-efficacy to come out fine. But those who come to college, accumulate debt, and then drop out without a degree are financially worse off than the ones who never tried, and just got a job after high school. For these students the national completion agenda is also a financial lifeline.

Five years of institution-level tracking at the University of Central Florida ("Tracking and Assessing UR Campus-wide: Demographics, Academic Success, and Post-Graduation Plans") clearly connect undergraduate research to student completion. Kimberly R. Schneider and colleagues found a 14.5-point difference in four-year graduation rates between research-involved students and the general population, 58% vs. 43.4%. This suggests that research is the kind of ideal intervention that improves both learning and completion, without adding time to degree. Similar findings are shared by Robin Cresiski et al. in "Undergraduate Research at a Teaching-Oriented College: Seniors' Perspectives and Approaches to Consider," set at a "highly diverse, open-access campus." "For seniors who participated in UGRs, a significantly larger proportion graduated by summer after reaching senior status or re-enrolled in the next fall (95.4%) compared to their peers who did not participate in UGR (88.3%), $\chi 2(1) = 8.66$, $p < 0.01$, phi = 0.07. The overall persistence boost is 7.1% for UGR participants against UGR non-participants (see Table 3 Column 4). The trends hold true for all subgroups examined, including minority, first-generation, and low-income students. A significantly higher proportion of students who participated in UGR persisted or graduated than their UGR non-participants, regardless of race and ethnicity, first-generation status, and low-income status."

Like so much of what we do - there are powerful implications for equity and social justice. "Can Undergraduate Research Participation Reduce the Equity Gap?" uses data from a pair of institutions in the University of Wisconsin system to support the field's longstanding claim that undergraduate research - like other HIPs - reduces gaps in graduate rates along racial and ethnic lines.

Such findings add another moral dimension to the affordability argument, and the clear methodology gives the rest of us a way to try this at home.

Quality

Marbled into the public concerns about college equity and affordability is the suspicion that we're really not worth it at any price. Whether they say so out loud or not, these critics are right if we think of college as the place where you learn what's already known. There is literally no need for graduates who can recite findings without questioning them, or adding to them.

Among all the high-impact practices named by George Kuh and others, research is the single most direct counterpoint to the conception of college as mostly memorization. Boiling that down - illuminating it as a set of particular interventions and teaching techniques - is in the interest not just of undergraduate research advocates, but of the whole higher education sector. In "A Taxonomy for Developing Undergraduate Research Experiences as High-Impact Practices," Abbey E. Fischer et al. provide "a layered taxonomy, with milestones of increasing engagement, that establishes what sets a HIP undergraduate research experience apart from other HIP experiences and what distinguishes good practices from high-impact teaching." These characteristics are visible, measurable, and repeatable. They show up in two other contributions to this issue, both related to the highest quality marker of all, regional accreditation. In "QEP is HIP: A Case Study Implementing an Institution-Wide Undergraduate Research Community of Inquiry for a Small, Private College Setting," Piedmont College shows how such transparency can lead to successful completion of a Quality Enhancement Project. And in "Leveling Up an Award-Winning UR Program: A Case Study from Furman University," the authors take us through the next step, showing how another Quality Enhancement Plan (QEP) process kickstarted undergraduate research featuring mentorship, reflection, and assessment.

So, equity, affordability, and quality. These are the themes and messages from this collection that can help us connect undergraduate research to the urgent work of higher education as a whole, presenting ourselves to leadership and the public not as one more problem to solve, but as a ready solution for the ones we have.

Colleges and universities originated when knowledge was harder to come by - before we had the printing press, let alone the web. College was where you picked up esoteric material you couldn't find anywhere else. Our inherited structures assume content is the most important kind of learning. To this day, our courses and curriculum are mostly lists of topics. Our older libraries were designed as warehouses for books, and some of them still look like it. The default classroom layout remains rows of chairs facing a lectern, whose very etymology means the instructor will stand behind it reading out loud. These days few would call that good teaching, but we're still looking for a successor paradigm with the same staying power. What should college mean, in a millennium where knowledge itself is literally everywhere, no longer cloistered, forbidden, or hidden? We're still about knowledge, but in a different way, no longer tasked with simply preserving, curating, and transmitting what's already known. Instead, we need to be *mostly* about creating more of it.

The journal issue you are about to read shows us that future, as it's emerging today. To live up to this conception of college means rethinking tools like the comprehensive exam, and even test proctors, and getting closer to an older, apprenticeship model of education. We need our students to know, but we also need them to understand ways of knowing, and to have a firsthand grasp of how knowledge grows. Experience with faculty conducting original research gives students the chance to internalize different epistemologies, understanding through disciplinary lenses concepts like evidence, ambiguity, knowing, and truth. In other words, we're going for a familiar "learn by doing" ethic, but increasingly what we need our students doing is the learning itself, by asking them questions no one knows the answer to.

We also want graduates who can understand current events and civic decision making deeply, and with enough breadth of understanding to know what's knowable, and when they're being snowed.

There's a lot of upside here, for faculty as well as students. For decades, our professors have been told the twin obligations of teaching and scholarship are mutually reinforcing, but they've had a hard time getting it to work. Instead, faculty positions - especially on the tenure track - can feel like two competing full-time jobs. But bringing students into disciplinary research punches a hole in the wall between the demands of classroom teaching and publishing. People can pass ideas back and forth, and breathe. For students, participation in research makes the degree evergreen, a self-renewing way of understanding the world, and continuing to learn about it.

There's a lot at stake. The institutions of higher education are under new scrutiny for good reason: we're too inequitable, too expensive, and too complacent for our own good. We can no longer justify our shortcomings on the strength of a degree conceived as a container for four years of static received wisdom.

The issue you're reading is a blueprint for a better model, not just of teaching and learning, but of college itself.

References

Scott-Clayton, Judith. 2018. The looming student loan default crisis is worse than we thought. *Evidence Speaks Reports*, Vol 2, 34 January 10, 2018. https://www.brookings.edu/wp-content/uploads/2018/01/scott-clayton-report.pdf.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 8-8.
doi: 10.14434/josotl.v21i1.32478

Stories of Impact: The Transformative Power of Undergraduate Research

Introduction

Sara Evans
Kennesaw State University
sevan120@kennesaw.edu

Jocelyn Evans
University of West Florida

Kristi Wilkum
University of Wisconsin Oshkosh

We, along with being guest editors of this issue, are also active researchers in our respective disciplines and the scholarship of teaching and learning. We integrate undergraduate research (UGR) as High Impact Practice (HIP) in most of our research projects, and have personal experiences in which we see all the benefits come to life that have been outlined in the series of papers in this issue. As we read abstracts and considered the organization and content for this issue, we began to notice a pattern in some of the abstracts that aligned with our own work and discussions with colleagues, but is generally not present in a traditional scholarly article. That element is the personal narrative account of impact. We know from the extensive literature cited throughout this issue, as well as the work in this section, that providing high-quality undergraduate research projects has substantial impacts at many levels – for individual students, for cohorts, for departments, colleges, universities, and even systems. We, as scholars, see these impacts every day in our own work and the work of others. However, it is not often captured in peer-reviewed research outside of quotes to support evidence of assessment results (which of course, have their own important place in this work).

We wanted to provide a slightly different arena in which authors could describe and discuss the impact of their work or experience. The result is this section on "Stories of Impact." What you will find in this section is a deviation from the traditional empirical research article, but one we hope you find valuable in a slightly different way. As researchers we can sometimes forget the real, human effects that our work has and we are often not privy to some of those effects that happen later in time or at other levels in our system. In this section you will read a number of articles that discuss impact of some type. You will see a progression of stories, beginning with a narrative account completely from a student-turned-faculty voice on the impact of his first UGR experience and how it continues to impact his work as a professor, and ending with an account of several faculty members who draw more heavily from the literature on creativity and arts education.

These articles represent anecdotal accounts at particular institutions with their own unique contexts, but they highlight benefits many have experienced as individual teacher/scholars and across our own campuses. They humanize the very real impact on so many dimensions of student development and make engagement in UGR seem approachable and more navigable than perhaps faculty new to these pedagogical practices may assume it to be. We hope readers enjoy these narrative accounts as much as we have, and that they inspire new inquiries into UGR that some have never considered before.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 9-12.
doi: 10.14434/josotl.v21i1.32461

The Course of a Life: The High Impact of Undergraduate Research and Mentoring

Christopher J. Young
Indiana University Northwest

The trajectory of my life changed in the most mundane of ways. It was on the first day of classes during my junior year in college. While seated at a desk in a classroom in the Armory at the University of Illinois, I awaited eagerly for what would be my first upper-division history course: Professor Robert McColley's course on Early National America, which covered the period roughly from the 1780s to the 1820s. After introducing the class, the professor handed out a list of topics and assigned one of them to each of us. My topic was William Blount (1749-1800). Who was William Blount, I wondered. The assignment was to write a research paper that would be due at the end of the semester.

As a first-generation student, I had had a rough start to college, but by the end of my sophomore year I had hit my stride. My plan was to become a high school history teacher. Finally, I was able to take an upper-division history course! I was excited and ready to go. Little did I know that my plans would change in roughly sixteen weeks.


Figure 1. William Blount.

I delved into the topic of William Blount. He proved to be a fascinating character during the nascent period of our nation's history. The very newness of the experiment in republican government during the 1790s and the expanse of the American Republic made for nebulous boundaries, loyalties, and principles. Studying the enigma who was the Governor of the Territory South of the River Ohio and later the first senator from the newly created state of Tennessee brought me into the riveting political cultural milieu of the 1790s—a period that would demand my attention from this initial entry as an undergraduate until I was tenured as an associate professor. It beckons me still from time to time.

The hunt for information about William Blount energized me. I loved reading about him! Every time I came across a primary document that mentioned the man I tingled as if I was the first person to uncover this document. It was only the first time for me, but it *felt* like I was on to something, like I was the only one interested in this remarkable human being. How could people not be talking about this person all of the time? Why wasn't he taught in American history survey courses? Why is this the first time I am learning about him? I felt like a sleuth. I called his home in Knoxville, asked questions, requested material, and then felt like a kid on Christmas when his home sent me brochures and other material that I could use. The same for local historical societies in eastern Tennessee.

Figure 2. Map of Tennessee (1795).

Then came the writing. My Mom read and commented on so many drafts while I was home for Thanksgiving break that year, that she, too, became intrigued by "Mr. Blount" who we would talk about from time to time for years to come. Research tends to do that—make a subject yours for life.

Since it was my first research paper for my first upper division course, I was particularly anxious when I turned it in. When Professor McColley returned it, I read each comment before turning to the next page, resisting the urge to go straight to the last page. When I reached the final page, I was stunned when I saw A+! I couldn't believe it. I was thrilled. In his comments, Professor McColley commented on how thoroughly I did my research and noted that I had a "scholarly disposition." I *loved* doing the research and the writing. And now those comments from my professor. I was hooked! I felt like Abraham Lincoln did when he responded on April 29, 1860, to Lyman Trumbull's inquiries regarding his presidential ambitions, "The taste *is* in my mouth a little." As Lincoln's experience in the 1858 Illinois Senate race affected his future ambitions, so did this undergraduate research experience affect my own. Instead of moving on to other courses for a Social Science Second Education degree, I decided that I wanted to be a historian.

When it came time for me to do a senior honors thesis, I chose Professor McColley to be my advisor. It was a one-year project. We met weekly and I thoroughly enjoyed our discussions. My topic was American Indian policy during George Washington's presidency. At the end of a year of research and writing, the candidate had to defend the project before one's advisor and one other faculty member. When that day I arrived, I wore the best clothes I had and arrived on time. I was really nervous. When I finally sat down in Professor McColley's office, while he and another professor were settling in, I remember seeing pigeons outside his window and thought about how nervous I was and how calm they seemed. It was a timely and memorable distraction. After the defense, I was asked to leave the office and wait in the hallway while they discussed my performance. If I was nervous before, I was even more so now. I was to be judged. This moment would come back to me eight years later when I was once again asked to wait in the hall while a committee decided on my dissertation defense. Having been in this situation before helped cool my nerves at that time.

After I received my first appointment as an assistant professor at MacMurray College in central Illinois, I learned from my predecessor that he knew Professor McColley and that he had contacted him to ask about me during the search. The fact that I got the job made me assume my former mentor spoke well of me. If he had not, surely, I would not have been hired since I was to learn in time that the two men were longtime friends and colleagues. While at MacMurray College, I organized a symposium on slavery during the age of Stephen Douglas (Stephen Douglas had been a resident of Jacksonville, Illinois, at the beginning of his political career). I invited Professor McColley to give a presentation, and he agreed. It was rewarding to see my undergraduate mentor presenting at the symposium and then getting to know my wife when we went to diner afterward. Several years later when I was working on a project as an assistant professor at a different institution, I had to visit the archives at my alma mater. When I finished my research, I met Professor McColley and we went to lunch before he drove me to the Amtrak station. Relationships forged through conversation and mentorship during college remain into our professional lives.

My research projects as an undergraduate provided the opportunity to establish a close relationship with a faculty member at a large research institution. That relationship encouraged me to pursue and develop my intellectual interests, and to imagine myself in a profession that was different than what I had in mind before I stepped into Professor McColley's classroom. He was a teacher-scholar who engaged in a high-impact practice. And that changed my life—and I like to think, through me, the lives of my students.

In my career as a faculty member, I have enjoyed encouraging students to take the deep dive into a research project. In that time, several of my students have published their work. One of them, while working on a topic closely related to his family's and Illinois's history with coal mining, reconciled his relationship with his father, which led to a hunting trip. Out of gratitude, he gave me half of the antler and a cooler of venison as a way of saying thank you. I was moved. I keep the antlers in my office as a reminder of the importance of relationships forged with our students and the students with us. Undergraduate research facilitates critical interpersonal developments and relationships that contribute to student success and enhanced life satisfaction.

Over the last eight years, I have organized the undergraduate research conference on our campus. My memory of the impact of undergraduate research and Professor McColley's mentorship on my own career—and life—trajectory reminds me that the annual conference isn't simply another campus event. I suspect that the faculty-regulars who participate had similar experiences as I did as an undergraduate and know in their hearts that the annual conference holds out the promise to be transformative in the lives of our students.

My research experience as an undergraduate and the relationship forged through it was a transformative experience. I learned that a topic will stay with you when you make it your own; words spoken and written to a student matter and can be life-changing; feelings experienced at one time can serve to inform similar feels at another time; and networks developed through undergraduate research open the doors to professional opportunities. Moreover, the experience gets at the essence of our humanity, the interconnectivity that binds us in a mysterious way.

After writing this essay, I decided to give Professor McColley a call. He is in his 87th year and as sharp and articulate as ever. And just like our interactions when I was an undergraduate, I left our conversation with a list of three books that I need to read and that we'd discuss next time we talked. And like the first assignment I received from Professor McColley, I felt excited and energized about the new things I'd learn in the coming days and months.

References

Reid, J. (1795) A map of Tennessee government, formerly part of North Carolina [S.l] [Map] Retrieved from the Library of Congress, https://www.loc.gov/item/99446175/.

William Blount, 1744-1800, bust portrait, facing right. nd. Retrieved from the Library of Congress, https://www.loc.gov/pictures/item/2005686050/.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 13-16
doi: 10.14434/josotl.v21i1.30368

The Impact of Applied Research: Student Research as a High Impact Practice in Freshman Environmental Science

Billy Morris
Georgia Highlands College

The Concept

I teach environmental science at Georgia Highlands College in Rome, GA. The campus is approximately 200 acres in size and includes a 50-acre lake, 15 acres of wetlands, and two streams. It presents many opportunities for undergraduate research in environmental science, especially for non-science majors.

In the spring of 2019 and with the support of my dean, I made plans to omit the lab manual used in Environmental Science for fall 2019 and began to acquire field supplies and testing equipment for various air, soil, water, and wildlife studies while compiling a list of campus research projects suitable for undergraduate non-science majors. My teaching goals for the course centered on utilizing student research as a high-impact practice by asking students to engage in scientific inquiry and methods rather than follow a scripted lab exercise. The schedule for the research projects included five phases: 1) identifying the question and proposing an investigation, 2) identifying lab equipment and analytical methods required, 3) establishing a sampling plan, 4) data analysis, and 5) discussion, conclusion, and campus poster session. I allowed students to work individually or in groups of no more than three. Collaboration was encouraged, and a class of 17 students produced 11 discreet research projects addressing water quality in campus watersheds, wildlife surveys, tree surveys, soil analyses, and air quality.

The Process

Managing these projects felt like overseeing a three-ring circus at times, particularly in phase one and two – identifying a research question and analytical methods required to investigate it. Each project used different equipment and techniques to sample, process, and analyze the parameters of interest, and students needed instruction and training to gain proficiency. The impossibility of managing many projects at the same time forced me to trust students to learn and practice lab skills on their own, and as each project reached a milestone of writing, analytical technique, or merely a question about how to proceed, a queue formed at my desk and the powerful effect of frequent and meaningful feedback was manifested. As we brainstormed together about ideas, techniques, and adjustments, students were motivated, curious, and willing to work toward improving writing skills, research methods, and presentation skills. They practiced critical thinking as they worked to solve problems encountered in the field, lab, and data analysis. It didn't take long for them to demonstrate to me that they were proficient in the operation of their respective analytical tools, field gear, and laboratory protocols, and we found a comfortable routine. For the next eight weeks, a combined lecture and lab once a week gave them ample time to gather their supplies, go to their respective field areas, collect data, and return to the lab for analysis and record keeping. Many students returned after regular class hours to work on their projects.

As the semester came to an end, I invited our dean of libraries to our class for a presentation on creating a poster, and in a hands-on demonstration, he led us through a critique of many poster examples and concluded with a lib-guide on best practices for creating quality presentation posters. The final phase of the student research project consisted of creating a poster that included an abstract, introduction, methodology, discussion, conclusion, citations, and appropriate graphics. The class peer reviewed their own rough drafts and crafted final versions over a period of two weeks. Files were uploaded to the college's poster printer queue and delivered to the class one week before presentation day. A practice poster session was held during class a few days before. On the last day of the fall semester, students set up their posters in the Student Center for two hours, where more than two hundred students, faculty, administrators, and community members circulated, talking with students and asking questions about their work. This was the first time a research-project-poster session had been held at Georgia Highlands, and the excitement and positive feedback was overwhelming.

A Case Study

One project deserves to be mentioned in particular. The work of three students took an unexpected turn and underscored the dynamic nature of research. These students were completing a pH comparison of lake, wetlands, and stream areas. Over six weeks, they collected dozens of samples. The students reported that they observed some high pH values – 9 to 10, which is toxic to most aquatic life – and had repeated the test with the same results. Furthermore, the high values were only observed from the parking lot storm drain spillway area in a small part of the lake. A comparison between rainfall events and their data spikes showed a strong correlation – that is, their high value observations occurred after rain events. They recognized that parking lot stormwater runoff was likely responsible for high values and questioned if the recent application of parking lot sealcoat was responsible for the anomalous pH values. They also recognized that the pH of sealcoat may not be the most important environmental concern; rather, it could be a proxy effect that signified other physical and chemical processes at work. They requested the safety data sheet on the sealcoat product, which revealed it was a coal-tar based product that contained significant amounts of polycyclic aromatic hydrocarbons (PAH) - compounds that are recognized by the United States Environmental Protection Administration as known carcinogens, mutagens, teratogens, as well as acute toxins in aquatic ecosystems (GemSeal Pavement Products, 2019).

As coal-tar-based sealcoat ages, it wears into small particles with high levels of PAHs that can be tracked into homes or buildings and incorporated into interior dust. For people who live adjacent to coal-tar sealcoat pavement, ingestion of PAH-contaminated house dust and soil results in an elevated potential cancer risk, particularly for young children. Exposure to PAHs, especially early in childhood, has been linked by health professionals to an increased risk of lung, skin, bladder, and respiratory cancers (Mahler et al., 2016).

As students processed this information, they realized that what began as a routine survey of water chemistry had turned into something very different. When their findings were conveyed to college administrators several things happened – public access to the lake was closed (it's widely used by the community for walking and fishing), an independent environmental testing firm was engaged to collect and sample the stormwater drain pathway and lake sediment for the presence of PAH compounds, and samples of air in campus buildings were collected for analysis of PAH compounds. Results of the tests were positive for stormwater sediment samples and negative for other areas of the lake and indoor air (Professional Environmental Management, 2020). Additional tests are planned, as students expect the particles of sealcoat fragments will eventually make their way into the lake sediment, where it can enter the aquatic food chain.

The students submitted a proposal to present their work at the National Conference on Undergraduate Research (NCUR) in Bozeman, MT in late March 2020, and were accepted. Unfortunately, the conference was cancelled due to COVID-19, but they were able to present in a virtual session held in April. During their presentation, they stated that when they began the course, they were simply looking to complete a science requirement for graduation, and the specific project they chose seemed to be an "easy" one. They commented on the profound effect that their routine scientific observations had brought about: campus community awareness and campus newspaper articles, the closure of public access areas, university system intervention, independent lab analyses, and environmental activism related to health and safety of humans and ecosystems. When they learned that their research was accepted for presentation at NCUR and the college had agreed to pay all expenses for the trip, I was fortunate to be with them and literally see their eyes grow wide with a fuller understanding of what had occurred as a result of their research project. Each of them told me that the most important lesson they learned is how a simple question can lead to a completely unexpected place with many more questions. To watch them experience the true nature of scientific inquiry was the highlight of my year, and is, of course, the reason we are in this business in the first place. I am fortunate to have administrative leaders who foster and encourage this type of experiential learning practice with non-STEM students. In my opinion, these students benefit the most from such practices.

Conclusion

Many lessons were learned by utilizing the high-impact practice of student research in my course, and I encourage others to consider implementing such a project into their courses as appropriate. Student participation in designing their own research projects led to increased student engagement and enhanced learning. Students who were encouraged to investigate their own interests within the learning objectives of the course were motivated, curious, and willing to work toward improving writing skills, research methods, and presentation skills. They practiced critical thinking skills as they worked to solve problems encountered in the field, lab, and data analysis. Frequent and meaningful feedback between students and the instructor ensured that students stayed on track and were accountable for making progress. A campus poster session at the conclusion of the semester allowed students to explore graphic design and develop public speaking skills.

The teaching load at two-year institutions typically doesn't allow time for our own research, let alone supervising students – it's up to faculty to find a way to utilize the time we have. With supportive leadership, existing course time can be used to make large or small changes. Give students the chance to identify something that they are interested in as it relates to course content. Let the passion you have for your discipline show – it's contagious! Keep them between the guard rails but let them wander all over the road. Be prepared for surprises and embrace new ideas and opportunities. Involve and engage your colleagues. Keep records. Most of all, show your students the joy and excitement of learning, exploring, and following the new questions.

Acknowledgments

Many thanks and much appreciation to Dr. Sarah Coakley, Dean, School of STEM, and Jason Chrisian, Division Chair of STEM, for your support and engagement during this project. You never failed to offer encouragement and positive feedback for this class as we navigated the investigations.

References

GemSeal Pavement Products. (2019). GemSeal ®Fed Spec Sealer and Fed Spec HS Sealer [Data file]. https://www.gemsealproducts.com/wp-content/uploads/2016/05/fed-spec-sds_5-19.pdf

Mahler, B.J. , Woodside, M.D., & Van Metre, P.C. (2016). Coal-tar-based pavement sealcoat – *Potential concerns for human health and aquatic life*. U.S Department of the Interior. http://dx.doi.org/10.3133/fs20163017

Professional Environmental Management. (2020). *Sediment testing for the presence of polycyclic aromatic hydrocarbons (PAHs) in Paris Lake*. [Unpublished report].

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp.. 17-20
doi: 10.14434/josotl.v21i1.30549

Undergraduate Research as an Institutional Ethos-A Case Study Examining a Faculty-Sponsored Research Symposium

Daniel M. Settlage
University of Arkansas – Fort Smith
dan.settlage@uafs.edu

Latisha A. Settlage
University of Arkansas – Fort Smith
latisha.settlage@uafs.edu

The importance of undergraduate research as a means of engaging students in higher order levels of thinking has become increasingly recognized in literature. Engaging undergraduate students in research has been shown to increase student-success outcomes including greater levels of retention (Kuh, 2008). Further research has demonstrated that high-impact practices including undergraduate research result in higher rates of faculty and peer interaction, increased critical thinking and writing skills, and higher levels of engagement (Brownell & Swaner, 2009). Additional studies (Kilgo, Sheets, & Pascarella, 2015; Craney et al. 2011) suggest that these benefits span disciplinary areas, and more still (Nnadozie, Ishiyama, & Chon, 2001; Lopatto, 2004; Russell, Hancock, & McCullough, 2007) conclude that undergraduate research opportunities help clarify students' interest in graduate level research and define their career paths. The literature further suggests that benefits accrue most greatly to those in underrepresented groups including racial minorities and first-generation students (Gregerman et al. 1998; Ishiyama, 2007; Barlow and Villarejo 2010; Finley & McNair, 2013).

Given these observations, it is somewhat surprising that undergraduate research is promoted at many institutions in a largely piecemeal approach, usually targeting relatively small groups of select students such as those who are part of an honors program or those who seek out independent study or special topics courses. This is particularly true of many smaller state and regional institutions that tend to lack the resources to fully support both graduate programs and other research programs, have high faculty teaching loads, and tend to enroll high levels of students from historically underserved socioeconomic and demographic profiles.

This article outlines one regional institution's approach to systematically promoting and embedding undergraduate research as a high-impact practice that is available to the entire student population. Following Tinto's model of student persistence, which emphasizes both academic performance and faculty-student relationships as necessary elements for student success (Tinto, 1987), the institution's Undergraduate Research Symposium (URS) is a formal process developed to encourage, display, reward, and celebrate undergraduate research accomplishments that arise from student-faculty research collaborations. The URS was first proposed in 2007 by the provost of the university to increase undergraduate student research engagement. Over the intervening years, it has expanded to include 115 research presentations in 2020, and it underwent a name change to the Student Research Symposium in 2017.

Background

In the inaugural year of its symposium, the campus was a mere five years removed from being a community college that had previously granted only associate degrees and technical certificates. At the inception of the URS, research expectations of students and faculty were minimal. Since that time, the role and scope of the institution has significantly expanded to include new baccalaureate and graduate programs, as well as a substantial change in research expectations on the part of faculty. During this time, the URS has evolved to help fulfill the mission and vision of the university. This institutional journey provides background and direction to those wishing to replicate the transformative impact of integrating undergraduate research by forming a high-impact, campus-wide undergraduate research symposium. The remainder of this article will describe the mechanics of implementing the URS and describe observed benefits of this high-impact practice.

Mechanics of the Symposium

A standing university committee manages the processes and procedures of the URS. The committee includes a diverse faculty representation of disciplines across the campus. It coordinates and reviews the submissions, selects the judges, and manages the logistics of the seminar itself. A standing call for submissions is posted on the campus website throughout the academic year and actively promoted in the months leading up to the submission deadline. Students may submit projects in one of three categories: oral presentation, poster presentation, or artistic expression. Artistic expression includes studio or performing art. Performances are recorded and presented as viewings, rather than given as live performances. Poster presenters, studio and performing artists must be present during the symposium to discuss their projects with judges and other attendees.

Individual students and groups (of five or fewer members) work closely throughout the year on research projects that are guided and supervised by a faculty sponsor. Faculty sponsors provide students with guidance regarding abstract and project preparation, as well as support when seeking institutional review board approval (when needed). The faculty sponsors serve not only as research mentors, but as the first step in the quality assurance process. Sponsoring faculty members are required to proofread the individual or team abstract, and all abstract submissions come directly from the sponsoring faculty member. Substandard abstracts risk non-acceptance by the URS committee. Projects are encouraged from all areas of study and from students of any class standing. They may arise as the result of a class project or an independent research collaboration.

All accepted submissions are grouped with projects that are from similar disciplines and are judged by a panel of faculty selected by the URS committee. To reward academic performance, presentations, posters, and artists are judged on the following criteria (as pertinent): quality of written abstract, effectiveness of introduction, overall presentation quality, level of difficulty, accuracy of results, neatness/organization of format, form, content, craftsmanship, synthesis, creativity, engagement with audience, preparation, conclusion, and ability to respond to questions. Several top projects receive cash scholarships supported by the Office of the Provost and are spotlighted on the institution's social media.

Benefits of the Symposium

For many students, the URS is an introduction to further academic research. Many continue to present the same or future research at state, regional, national, or international conferences. In addition, undergraduate participants have successfully used their experiences as a springboard to graduate programs. Participation in the URS not only provides students with an advantage at application time, it empowers them with the foundation of research skills needed to excel in graduate school. This is an especially important experience for students in the socioeconomic and demographic profiles that are typically underrepresented in graduate school.

For faculty, the URS has served to increase faculty involvement in collaborative research with students and stimulate an increase in peer-reviewed presentations and publications. Many fruitful research projects began as a faculty guided ideas that saw first light at the URS. These presentations served as the steppingstone to more fully developed research ideas that have ultimately evolved into peer-reviewed journal articles. This is an especially important consideration at institutions that typically lack graduate programs and other infrastructure to fully support research activities, yet still require research from their faculty members. Perhaps even more important than potential publication is the human side of the experience. Engagement in the URS has deeply affected both student and faculty participants.

One example of a student-faculty project involved a cluster analysis of the regional economy. The student research was published in a quarterly report distributed to the community via the university's economic outreach center and had a clear impact on the student's future direction:

> "I'd asked my professor if there was a project I could do that would give me a good feel for the field of economics, an area I'm interested in studying in graduate school. The project was a challenge, but the opportunity to use current theory and methods to address practical issues was very exciting to me."

Another project resulted in the student-faculty duo receiving a small research grant to complete their research project. The importance of the student-faculty mentoring model was clear in this student's assessment of the project:

> "I am very thankful to have been mentored through this process. This institution offers a unique college experience. The professors are willing to work with the students and engage in the students' lives. It has been an amazing experience that I will never forget."

Faculty members have also found participating in the symposium as a sponsor and judge to be an enriching experience:

> "Serving as a judge for the URS has been an extremely rewarding experience. The scope of projects and the level of professionalism has been outstanding. It has inspired me to broaden my research base by working on projects with current students. This has become one of the most engaging and fruitful research activities in my portfolio."

Conclusions

Using a regional, teaching-focused state university as a case study, this article documents the formation and growth of a campus-wide annual URS and examines several positive changes in the institution's culture toward research as a result. The symposium is an idea that is easily adaptable and extendable to fit a wide variety of institutions and colleges. It can be scaled up to fit a large intuition or scaled down to fit within a single college on a large campus. The benefits of embedding undergraduate research in the ethos of the institution at such a deep level are powerful and widespread. Creating and enhancing a vibrant culture of research fosters a symbiotic relationship. Students, faculty, and the institution all benefit from placing an increased value on the undergraduate research experience.

References

Barlow, A. E., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching*, 41(9), 861-881.

Brownell, J. E., & Swaner, L. E. (2009). High-impact practices: Applying the learning outcomes literature to the development of successful campus programs. *Peer Review*, 11(2), 26.

Craney, C., McKay, T., Mazzeo, A., Morris, J., Prigodich, C., & De Groot, R. (2011). Cross-discipline perceptions of the undergraduate research experience. *The Journal of Higher Education*, 82(1), 92-113.

Finley, A., & McNair, T. (2013). *Assessing underserved students' engagement in high-impact practices*. Association of American Colleges and Universities. 1818 R Street, NW, Washington, DC 20009.

Gregerman, S. R., Lerner, J. S., Von Hippel, W., Jonides, J., & Nagda, B. A. (1998). Undergraduate student-faculty research partnerships affect student retention. *The Review of Higher Education*, 22(1), 55-72.

Ishiyama, J. (2007). Expectations and perceptions of undergraduate research mentoring: Comparing first generation, low income white/Caucasian and African American students. *College Student Journal*, 41(3), 540.

Kilgo, C. A., Sheets, J. K. E., & Pascarella, E. T. (2015). The link between high-impact practices and student learning: Some longitudinal evidence. *Higher Education*, 69(4), 509-525.

Kuh, G. D. (2008). Excerpt from high-impact educational practices: What they are, who has access to them, and why they matter. *Association of American Colleges and Universities*, *14*(3), 28-29.

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First findings. *Cell Biology Education,* 3(4), 270-277.

Nnadozie, E., Ishiyama, J., & Chon, J. (2001). Undergraduate research internships and graduate school success. *Journal of College Student Development*, 42(2), 145-156.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science*, 316(5824), 548-549.

Tinto, V. (1987). *Leaving college: Rethinking the causes and cures of student attrition*. University of Chicago Press, 5801 S. Ellis Avenue, Chicago, IL 60637.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp.21-24.
doi: 10.14434/josotl.v21i1.30549

The Impact of Service-Oriented Undergraduate Research on an Ongoing Participatory Community Action Research Project at Homeless Shelters

Jennifer L. Zicka
University of Dayton

Roger N. Reeb
University of Dayton
rreeb1@udayton.edu

Introduction

This article is a genuine contribution between an undergraduate student (Jennifer Zicka) and her mentor (Dr. Roger Reeb). Jennifer made unique contributions to an ongoing project that empowers and supports guests at homeless shelters as they strive to overcome personal challenges and obstacles related to homelessness. After a brief description of the Project, we celebrate Jennifer's unique contributions, which sets the stage for the centerpiece of the article – Jennifer's heartfelt reflection on how this experiential learning contributed to her civic-related development, personal growth, and the pursuit of her dream career.

Background

The *Participatory Community Action Research Project at Homeless Shelters* represents a decade-old collaboration between Dr. Reeb (Professor of Psychology) at the University of Dayton (UD) and St. Vincent de Paul (Dayton, OH). The Project implements *behavioral activation* for shelter residents by providing them opportunities to engage in productive activities that lead to response-contingent reinforcement *(a rewarding experience following an accomplishment)*. The response-contingent reinforcement increases productive behavior and improvements in general empowerment (sense of mastery), quality of life, mood, and reasoning skills (Kanter et al., 2010). *To our knowledge, there is no prior documentation of using behavioral activation in homeless shelters.* At UD, the Project is affiliated with the Human Rights Center, the Hanley Sustainability Institute, and the Fitz Center for Leadership in Community. Examples of community partners in Montgomery County (Ohio) include: the Office of Re-Entry; the National Alliance on Mental Illness; Narcotics Anonymous; Alcoholics Anonymous; Hospice of Dayton; and the Ohio State University Agricultural Extension.

Following an orientation, service-learning students work alongside graduate students, faculty, and community partners to provide three interrelated categories of behavioral activation sessions. One category of sessions enhances *self-sufficiency/empowerment*, such as computer training, job preparation, and improving access to community resources. A second category of sessions improve *social support and coping* of guests, including stress management training, support groups, and prevention programs. Finally, the third category of sessions improve *the shelter's social climate* through events such as cookouts and art and music activities, which enhance the establishment of rapport among shelter guests and students, making the other two categories of sessions possible. The Project also hosts community partners to provide sessions to guests.

Over 1,500 shelter guests have participated in the Project, and quantitative and qualitative research documents the Project's benefit for their psychological development (Reeb, Elvers, et al., 2017; Reeb et al., 2021). Well over 300 service-learning students have assisted with this Project, many across multiple semesters. The Project is associated with Dr. Reeb's course, *Engaged Scholarship for Homelessness: A Service-Learning Course*, though students can assist by enrolling in other credit-bearing service-learning courses. Throughout the semester, students reflect on social justice and human rights issues that are pertinent to their service activities. Quantitative and qualitative research documents civic-related development in these students, such as decreases in stigmatizing attitudes, increases in self-efficacy (confidence) for community service, and improvements in awareness of privilege and oppression (Reeb, Hunt, et al., 2017; Reeb et al., 2021). *With our research infrastructure, students assist in sustaining the Project, and some students, such as Jennifer, even develop and conduct individualized studies that reflect their interests and career aspirations.*

Undergraduate Contributes to Research Project and Pursues Career Aspirations

Jennifer graduated from UD with a Bachelor of Science in psychology and a minor in biology, while also obtaining a Certificate in Deaf Studies from the University of Cincinnati. As an undergraduate, she assisted with various components of the Project over four semesters, including a summer semester supported by the Dean's Summer Fellowship Program, which is administered through the College of Arts and Sciences. Further, Jennifer completed an independent research capstone by conducting a unique and innovative study that coincided with her career goal of becoming an Audiologist who works with disadvantaged individuals. Her research examined the feasibility of teaching American Sign Language (ASL) in homeless shelters, which is important because individuals in poverty are more likely to suffer hearing impairments related to prematurity and low birthrate. In turn, individuals with hearing impairment face significant educational and occupational disadvantages (Kubba, et al., 2004; World Health Organization, 2016), which are exacerbated by homelessness (Weinreb et al., 2007), as documented in the authors' own community (*Target Dayton News*, 2015). An article in *New York Daily News* (2005) illustrates the demand for ASL resources in shelters: "The city's Department of Homeless Services agreed…to provide sign language interpreters to deaf people living in homeless shelters [and thereby] ending…lawsuits charging that the city was discriminating against the hearing-impaired." In fact, lack of such resources for deaf individuals in poverty is an international human rights issue (World Federation of the Deaf, 2016). The World Health Organization (2016) stated:

> In developing countries, children with hearing loss and deafness rarely receive any schooling. Adults with hearing loss also have a much higher unemployment rate. Among those who are employed, a higher percentage of people with hearing loss are in the lower grades of employment compared with the general workforce.

Programs such as Discovering Deaf Worlds have shown the benefit of providing sign language resources to those in poverty, including those in developing countries (Borgen Project, 2018).

The first author conducted a pilot study to determine the feasibility of providing ASL training in a chaotic homeless shelter and to ascertain if doing so would be beneficial. This pilot study included 24 shelter guests who volunteered to participate in ASL sessions and completed a brief validated measure of perceived benefits. As hypothesized, shelter guests perceived the ASL sessions as beneficial, meaningful, important, worthy of repeating, and enjoyable.

In the follow-up study, 34 shelter residents in ASL sessions completed pre- and post-session measures of both receptive and expressive language (adapted from the *Central Institute for the Deaf*). As hypothesized, shelter guests showed significant pre- to post-session improvements in both Receptive ASL and Expressive ASL. Quantitative findings were supported and illustrated in qualitive data (written comments by residents).

Jennifer's research was presented at the Stander Symposium at UD (Zicka, 2019) and the *Midwestern Psychological Association* (Zicka et al., 2019). Alongside her experience in research and presentation, Jennifer recognizes the impact of the experiential learning on her civic-related development and professional growth, as illustrated in her reflection below:

> *Although I completed coursework on deaf-related stigma, I was unaware of the double stigma experienced by deaf individuals who are experiencing homelessness. One deaf resident told me that people stay away from him and think he "talks funny." Some deaf residents felt uncomfortable and unable to participate in our behavioral activation sessions, but with my support, these individuals participated. Introducing ASL to the shelters reduced some of the stigma surrounding deafness, and this is consistent with research showing that reducing stigma involves both education and contact with the stigmatized population.*
>
> *My work on this Project, supported by my new knowledge of the relationship between poverty and deafness and the need for ASL support in homeless shelters, increased my awareness of privilege and oppression. Since I was lucky enough to be born into an economically comfortable family, I never needed something without being able to get it. Things such as going to a doctor's appointment, having access to a phone, obtaining employment, and finding transportation are major struggles for homeless individuals, and such struggles are exacerbated by disabilities and health problems.*
>
> *My experiences on this Project over four semesters, accompanied by my Independent Research Capstone and my individualized work with deaf residents, greatly contributed to my professional development; that is, it enhanced my sense of community service self-efficacy, which is a person's confidence in making contributions to the community. In addition, I learned a great deal about agencies that provide resources for deaf individuals (e.g., DeafLEAD; Dayton Deaf Community Resource Center), and I provided the shelters with contact information for these resources. Due to my work on this ongoing Project, as well as my other academic accomplishments, I was awarded the Dean Leonard A. Mann, S.M. Award of Excellence at UD, which recognizes the outstanding senior in the College whose academic record and record of service embody the three characteristics of Learn, Lead, and Serve. Furthermore, after graduating from UD, I began taking pre-requisite classes to pursue my dream of becoming an Audiologist. While taking classes, I continued community service related to homelessness and also engaged in career-related research at a nearby university. Despite complications revolving around COVID-19, I applied to graduate schools, and I was accepted to Utah State University's Doctorate of Audiology Program. My immersion in research projects, such as the homeless shelter project described here, prepared me for graduate study in Audiology by helping me to understand how best to work with diverse (and disadvantaged) populations. With this experience and knowledge, I will see through stigma surrounding disability (and disadvantage) and provide person-centered clinical care.*

Future of the Project: An Undergraduate Student's Legacy

Due in part to the dedication of students such as Jennifer, we have sustained the Project's work and funding in the face of COVID-19, though much of our recent work has been remote. Despite COVID-19 restrictions, we even sustained the Shelter Farm, which was established as part of the Project in 2017 and in collaboration with The Ohio State University. The Shelter Farm, which exists on the grounds of the shelter in a food desert, has yielded about 5,000 pounds of produce for shelter guests. The Shelter Farm is pertinent to this article, because Jennifer was one student who contributed to it as she worked on the Project, as UD President Eric Spina noted on his blog (*"A Sign of Hope"*; https://udayton.edu/blogs/president/2018/10/a_sign_of_hope.php.) wherein he comments on Jennifer's presentation to UD's Board of Trustees regarding her overall work on this Project.

References

Borgen Project (2018). *Sign language education in developing countries*. Retrieved from: https://borgenproject.org/sign-language-developing-countries/

Central Institute for the Deaf. (n.d.). CID early childhood vocabulary rating forms. Retrieved from: https://professionals.cid.edu/product/cid-early-childhood-vocabulary-rating-forms/

Deaf Community Resource Center. (n.d.). Retrieved from: https://www.dcrcohio.org/

DeafLEAD. (n.d.). Retrieved from: https://www.deafinc.org/deaflead/services.html

Discovering Deaf Worlds. (n.d.). Retrieved from: https://www.deafworlds.org

Kubba, H., MacAndie, C., Ritchie, & MacFarlane, M. (2004). Is deafness a disease of poverty? Association between socioeconomic deprivation and congenital hearing impairment. *International Journal of Audiology, 43(3),* 123-1125. https://doi.org/10.1080/14992020400050017

Los Angeles Times (1990). *Deaf struggle for help from homeless agencies.* Retrieved from: http://articles.latimes.com/1990-03-07/news/ga-1855_1_union-station

New York Daily News (2015). *Deaf people in NYC homeless shelters will gain access to sign language interpreters*. Retrieved from: https://www.nydailynews.com/new-york/nyc-deaf-homeless-people-gain-interpreters-shelters-article-1.2404490

Reeb, R.N., Elvers, G., et al. (2017, September). Participatory community action research in homeless shelters: Outcomes for homeless shelter residents [Paper presentation]. International Association for Research on Service-Learning and Community Engagement, Galway, Ireland.

Reeb, R.N., Elvers, G., Hunt, C.A., et al. (2020). Participatory community action research in homeless shelters: Outcomes for shelter residents and service-learning research assistants. [Manuscript in revise and resubmit for publication]. Department of Psychology, University of Dayton.

Reeb, R.N., Hunt, C., Elvers, G., Holcomb, J., Katsuyama, R., Fadoir, N., Wetter, S., O'Koon, Longstreth, M., Nelson, M., & Hartman, C. (2017, September). *Outcomes for service-learning students implementing participatory community action research in homeless shelters* [Paper presentation]. International Association for Research on Service-Learning and Community Engagement, Galway, Ireland.

Target Dayton News (2015). *Deaf and homeless.* Retrieved from: http://www.targetdayton.com/hp_wordpress/wp-content/uploads/2015/09/Sept-Newsletter-2015.pdf

United Nations General Assembly. (1948). *Universal declaration of human right*s. Retrieved from: https://www.ohchr.org/EN/UDHR/Documents/UDHR_Translations/eng.pdf

Weinreb, L., Gelberg, L., Arangua, L & Sullivan, M. (2007). Homelessness and health problems. In D. Levinson, & M. Ross (Eds), *Homelessness handbook* (pp. 188-198).

World Federation of the Deaf (2016). Advancing human rights and sign language worldwide. Retrieved from: http://wfdeaf.org/our-work/human-rights-of-the-deaf/

World Health Organization (2018). *Deafness and hearing loss*. Retrieved from: https://www.who.int/en/news-room/fact-sheets/detail/deafness-and-hearing-loss

Zicka, J. (2019, April). Behavioral activation research project in homeless shelters. Presented at the *Stander Symposium at the University of Dayton*, Dayton, OH.

Zicka, J., Reeb, R.N., & Gibbins, K. (2019, April). Efficacy of teaching American Sign Language in homeless shelters. Poster presented at the *Midwestern Psychological Association*, Chicago, IL.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 25-29
doi: 10.14434/josotl.v21i1.30391

Career Readiness Driven by Sequential CUREs

Patrick J Killion
University of Maryland
pkillion@umd.edu

Ian B Page
University of Maryland

Alexis Boytim
University of Maryland

Introduction

The University of Maryland (UMD) First-Year Innovation & Research Experience (FIRE) was launched in 2014 (Killion & Page, 2016; Killion, Page, & Yu, 2019; The University of Maryland, n.d.). The initial focus of the program was to provide authentic faculty-led research experiences, mentorship, and accelerated opportunities for first-year undergraduate students from a wide range of academic backgrounds. The program now impacts over 600 new first-year freshmen and transfer students annually through the operation of more than 15 independent research streams representing the natural, social, technological, and applied sciences.

FIRE is a university-wide program based on the Freshman Research Initiative (FRI), a large-scale, STEM-centered undergraduate research program established in the College of Natural Sciences at The University of Texas at Austin in 2006 (Beckham, Simmons, & Stovall, 2015; Rodenbusch et al., 2016; University of Texas at Austin, n.d.). Students participate in FIRE through the completion of a sequential three-semester course-based undergraduate research experience (CURE). The sequential nature enables students to cumulatively build personal and professional outcomes through a three-semester process of research preparation (FIRE Semester 1), training (FIRE Semester 2), and accomplishment (FIRE Semester 3). Optional mid-program (FIRE Summer Fellowships) and post-completion (FIRE Next Steps) opportunities allow students to develop leadership capacities in addition to their research training.

Extending the Impact: Career Readiness

Research-Centered Assessment of Program Impacts & Outcomes

The outcomes targeted by FIRE align broadly with several decades of scholarly research that has characterized the wide range of personal and academic outcomes for students in undergraduate research experiences (Auchincloss et al., 2014; Brownell et al., 2012; Elgin et al., 2016; Linn et al., 2015; National Academies of Sciences, Engineering, and Medicine, 2017). The FIRE program was developed to provide students the central features considered essential to CUREs. These include the use of authentic and contemporary research methods, the capacity to engage in the process of creating new knowledge, the engagement of work broadly relevant to the world around us as well as the specific discipline engaged, and the ability to repeat or revise aspects of the research to address unexpected challenges (AAAS, 2011; Auchincloss et al., 2014; National Academies of Sciences, Engineering, and Medicine, 2017).

Transitioning to a New Framework - Career Readiness

Through years of operation and reflective conversations with participating students and parents, it was determined that additional levels of professional relevance were needed to augment the research-centered program experiences and outcomes targeted. In 2019-20 the FIRE program engaged in an in-depth process of curricular and assessment reform to support the measured attainment of capacities directly connected to student professional development.

The FIRE program adopted the National Association of Colleges and Employers Career Readiness competencies (National Association of Colleges and Employers, n.d.). These include student capacities to use sound reasoning to analyze issues and make decisions and overcome problems (critical thinking); articulate ideas clearly (communication); build relationships representing diverse cultures, races, genders, religions, and viewpoints (collaboration); develop accountable and effective work habits (professionalism); and leverage the strengths of others to achieve common goals and use interpersonal skills to coach and develop others (leadership).

Professional Development & Career Readiness - A Student Perspective

Alexis Boytim - FIRE Student, Peer Mentor, Career-Ready Graduate

Alexis Boytim, a co-author of this manuscript, started at UMD in the fall semester of 2014 and joined the FIRE Sustainability Analytics research stream in the spring semester of 2015. After completing the FIRE course sequence, Boytim served as a FIRE peer mentor through FIRE's Next Steps program during the calendar year 2016. During this period of time, Boytim was instructed and mentored by Page, the founding research educator for FIRE Sustainability Analytics.

Degree-Relevant Research in the Social Sciences

Boytim started at UMD as an environmental science and technology major in the College of Agriculture and Natural Resources. She graduated in the spring semester of 2018 with a Bachelor of Science in Environmental Science and Technology with a concentration on Environmental Health and a minor in International Development and Conflict Management.

From her start at UMD, participation in the FIRE program accelerated her connection with her chosen major and academic department by providing her a deeply relevant research home: FIRE Sustainability Analytics. In this manner, FIRE's inclusion of the social sciences in its research mission opened the door to research engagements and professional development for first-year students like Boytim, who often struggle to find these opportunities amongst CUREs developed for more traditional STEM-centered disciplines.

Research Experience & Professional Development

As both a student and peer mentor in FIRE Sustainability Analytics, Boytim was deeply immersed in the authentic methods and broadly relevant work of applied economics. She recalls that:

> I experienced a steep learning curve using R, the computer programming language, to analyze and merge meta-datasets as a key part of our methodology. Dr. Page was understanding of the varying levels of expertise amongst his students and, for me, provided guidance to help improve my programming competency. As a mentor, Dr. Page was a great judge of how much room to leave for us to work through challenges on our own before stepping in to provide

> support. While difficult and often frustrating at times, working through trial-and-error independently or with peers taught me how to be self-reliant in a research setting. This gave me a great sense of self-confidence that helped me advance as a researcher.

Boytim went on to report that research experience and professional development were simultaneous and related outcomes of FIRE program participation. She states that:

> FIRE accelerated professional development for me by fostering key skills early on in my college experience. As a student researcher in the Sustainability Analytics Lab, we were expected to spend a minimum number of hours in the lab to complete our work in a timely manner. Being able to set a weekly lab schedule for myself around my courses and hold myself accountable allowed me to develop a mature, professional independence. Additionally, FIRE taught me how to think critically, to analyze data, to communicate information in different ways to different people, to write scientifically, and to work effectively both independently and with peers, among other skills. When I faced a challenge during my research, I was often encouraged to work independently or with peers to find possible solutions to overcome the hurdle rather than immediately submit to my faculty advisor. This fostered a sense of self-reliance that has helped me to this day in various leadership roles.

Success as Market Professional

Boytim is currently a director with Etna Community Organization (ECO), overseeing the planning, implementation, execution, and evaluation of ECO's community development initiatives. In this role, she is responsible for a broad range of logistical, operational, and community-based responsibilities requiring high levels of critical thinking, collaboration, and professionalism. She reports:

> The skills that I developed through FIRE have been instrumental in my professional success as the leader of a small community-based nonprofit organization. My position, by nature, requires me to take on a diverse array of responsibilities both to further our mission and to keep the organization operating. Balancing workload, budgeting time to ensure productivity, and holding myself accountable, as the only staff member of the organization, are mandatory to accomplishing the organization's goals, just as it was in FIRE.

Boytim reports that FIRE was central to the development of both hard and soft skills that have contributed to her professional success. With respect to her current position, she states:

> Many different stakeholders are involved in the community planning process of my work, including the municipal government, businesses, community groups, residents, and external partners. Having to work collaboratively with my FIRE peers of different backgrounds in a mature, respectful manner to accomplish our research goals has helped me successfully navigate this present work scenario. The organizational skills, the ability to work both independently and collaboratively, and the overall professionalism that were stressed in FIRE have also helped me succeed in my current position.

Summarily, Boytim communicated that FIRE was central to her professional development during her time as an undergraduate at UMD. She also shared:

At the end of the day, the full depth and breadth of lessons, and skills learned from FIRE that have helped me achieve success are wide and far-reaching. I can assuredly say that, without FIRE, I would not have been able to grow and advance as quickly or successfully in my current professional field. These particular skills that have helped me succeed in my current professional position include organization, interpersonal relationship-building, communication, analytical reading and writing, accountability, professionalism, collaboration, time management, problem-solving, patience, diligence, and more. Without FIRE, I do not think that I would be as confident in my leadership role, as effective in communicating ideas and working collaboratively with others, or as diligent to hold myself accountable and manage my time and work efficiently.

References

American Association for the Advancement of Science [AAAS]. (2011). *Vision and change in undergraduate biology education: A call to action*. Retrieved May 6, 2020 from https://visionandchange.org/about-vc-a-call-to-action-2011

Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., Lawrie, G., McLinn, C. M., Pelaez, N., Rowland, S., Towns, M., Trautmann, N. M., Varma-Nelson, P., Weston, T. J., & Dolan, E. L. (2014). Assessment of course-based undergraduate research experiences: A meeting report. *CBE—Life Sciences Education*, *13*(1), 29–40. https://doi.org/10.1187/cbe.14-01-0004

Beckham, J. T., Simmons, S. L., Stovall, G. M., & Farre, J. (2015). The Freshman Research Initiative as a model for addressing shortages and disparities in stem engagement. In M. A Peterson & Y. A Rubinstein, Directions for Mathematics Research Experience for Undergraduates (pp. 181–212). World Scientific. https://doi.org/10.1142/9789814630320_0010

Brownell, S. E., Kloser, M. J., Fukami, T., & Shavelson, R. (2012). Undergraduate biology lab courses: Comparing the impact of traditionally based, "cookbook" and authentic research-based courses on student lab experiences. *Journal of College Science Teaching*, *41*(4), 36.

Elgin, Sarah C. R., Gita Bangera, Sean M. Decatur, Erin L. Dolan, Laura Guertin, Wendy C. Newstetter, Elvyra F. San Juan, et al. 2016., "Insights from a Convocation: Integrating Discovery-Based Research into the Undergraduate Curriculum." *CBE—Life Sciences Education*, *15*(2): 1–7. doi: 10.1187/cbe.16-03-0118

Killion, P., & Page, I. (2016). University of Maryland's First-Year Innovation and Research Experience (FIRE) encourages student participation in policy-based research. *Council on Undergraduate Research Quarterly, 36*(3), 47.

Killion, P., Page, I., & Yu, V. (2019). Big-data analysis and visualization as research methods for a large-scale undergraduate research program at a research university. *Scholarship and Practice of Undergraduate Research*, *2*(4), 14–22. https://doi.org/10.18833/spur/2/4/7

Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*, *347*(6222), 1261757. https://doi.org/10.1126/science.1261757

National Academies of Sciences, Engineering, and Medicine. (2017). Undergraduate research experiences for stem students: Successes, challenges, and opportunities (J. Gentile, K. Brenner, & A. Stephens, Eds.). National Academies Press. https://doi.org/10.17226/24622

National Association of Colleges and Employers. (n.d.). Career Readiness Defined. Retrieved May 6, 2020, from https://www.naceweb.org/career-readiness/competencies/career-readiness-defined.

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. doi: 10.1187/cbe.16-03-0117

The University of Maryland. (n.d.). The First-Year Innovation & Research Experience. Retrieved May 6, 2020, from https://www.fire.umd.edu

University of Texas at Austin, College of Natural Sciences. (n.d.). Freshman Research Initiative. Retrieved May 6, 2020, from https://cns.utexas.edu/fri

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 30-34.
doi: 10.14434/josotl.v21i1.30356

The Impact of Continual Reflection Students as Partners: Becoming a/r/tographers

Diana Gregory
Kennesaw State University
dgregory@kennesaw.edu

Jonathan Fisher
Kennesaw State University

Hayley Leavitt
Kennesaw State University

Introduction

Research in visual arts, according to Winters (2015), is an unusual situation in that artists must offer details about how their artistic process represents a methodology, what its research methods are, and why this is an appropriate, reliable, and valid procedure. In this reflective article we are delineating a specific situation in which a/r/tography (Irwin, 2013) as a research methodology had a direct influence as a high-impact practice on an undergraduate's individual research project as well as collaborative work conducted with art and design co-co-principal investigators (coPI). We begin this reflective essay ever mindful of Sword's (2019) compelling question about writing research results with the identity-flattening pronoun *we* in situations where there is clearly a power imbalance between co-authors. We are Hayley, a Bachelor of Fine Arts (BFA) major who formulated undergraduate research projects as a co-investigator with Jonathan, a tenure track art and design faculty member coordinating foundation level courses who teaches ART 2990: Concepts, Creativity, and Studio Practice, and Diana, an art education professor whose research focus is creativity. Creativity, whether mundane or extraordinary, is an essential element in life (Richards, 2007). In art and design creative ability along with problem-solving ability are key expectations for students entering the field (National Association of Schools of Art and Design, 2019-2020). As art and design faculty, we recognize like Shreeve, Wareing, and Drew (2009) that from students' entrance into higher education and emergence into art and design fields as professionals, they are practitioners in their subject of study.

For Shulman (2005) signature pedagogies form habits of the mind, heart, and hand; they prefigure the cultures of professional work and provide socialization into the practices and values of a field (p. 59). Recognizing that creative education knowledge is unstable (Orr & Shreeve, 2018), Jonathan and I received approval from our university's Institutional Review Board (IRB) to conduct a longitudinal study "Effective teaching of conceptual inventiveness and creativity in visual arts" to uncover what is it about creativity that students learn in our program. In this article, we chronicle working together from fall 2017 through spring of 2020 to discover what Rita Irwin (2013) delineated as "becoming a/r/tography" (p. 198). We delineate how undergraduate research as a high-impact practice affected the research experience of an art and design major, and how a/r/tography as a research methodology influenced our research projects during this three-year period.

Becoming A/r/tography

A/r/tography is concerned with self-study, being in community, and relational and ethical inquiry (Irwin & Springgay, 2008, p. xix), while "living inquiry" refers to the ongoing practice of being an artist/researcher/teacher (p. xxix). Rita Irwin (2013) defined a/r/tography as "a research methodology, a creative practice, and a performative pedagogy that lives in the rhizomatic practices of the in-between" (p. 198). We found working as a/r/tographers "conceptualizing *becoming* (emphasis ours) within the multiplicities of our work" specifically in those "in-between spaces among the identities, practices, and processes of artists, researchers, and educators, and in the conditions of learning to learn" (p. 202) to be a synchronous research method that enhanced and deepened our scholarship of teaching and learning (SoTL) projects. As a methodology, it had a direct impact on Hayley's undergraduate research project(s) as well as the collaborative work she conducted with us as co-PIs. Jonathan and I began our SoTL journey focusing on signature pedagogies (Shulman, 2005) to understand why art and design students develop as they do, what forms of development and approaches enabled them to think and act as professional artists and designers. However, in art and design, Orr and Shreeve (2018) note the "sticky" creative curriculum leaves us with a tension between creativity and clarity, with a discomfort of not knowing all the answers, but with a need to support student learning (p. 157). The art and design curriculum is "sticky" since it is "messy and uncertain; values stick to it in ways that are difficult to see; it has an elasticity, being both sticky and stretchy; it is embodied and enacted – it sticks to the person; and it is troublesome and challenging" (p. 7).

As a/r/tographers, we pursued presenting our "living inquiry" moments not as end results, but as understandings of experiences along the way (Irwin & Springgay, 2008, p. xxix). To navigate our SoTL landscape (O'Brien, 2008) we asked: what is it that students learn about creativity; what activities enable the learning/growth/development to occur; and how to support students. Early case study results, presented at the 2017 International Society for the Scholarship of Teaching and Learning conference, included the impact of adding ART 2990: Concepts, Creativity, and Studio Practice to the foundation core curriculum; vertical and horizontal alignment (Angelo, 2012); and, a modified Creativity VALUE Rubric (AAC&U, 2009) in the assessment process (Gregory, Fisher, Brasco, Robson, & Sipp, 2017). While these results documented faculty (micro) and departmental (meso) steps toward meaningful change, student engagement, and most importantly, student voice was lacking (Felten, Bagg, Bumbry, Hill, Hornsby, Pratt, Weller, 2013) in our research focus. Through a/r/tography, we sought out critical friends to provoke us to think critically, and to inspire us to work creatively (Irwin, 2008). Although our presentation provided a rhizome – the groundwork/wire framework – for our learning to unfold and grow, the challenge was to perceive freshly, to notice the in-between spaces – the rhizomatic relations, looking for critical concepts rather than for isolated facts (Irwin & Springgray, 2008).

To include student voice in our research process, Jonathan and I held focus groups (Nagle & Casey, 2018) to document students' views on creativity in spring 2017. The focus group script was based on a creativity model developed by faculty in a School of Art and Design Faculty Learning Community from 2009-2011. The model included Sawyer's (2012) individualist and sociocultural approach to creativity and Runco's (2009) person, place, process, product (4P) perspective. At the end of our first session, we invited anyone interested in this research to contact us, and Hayley did. She asked if she could work with us on the focus group as a coPI. She completed CITI training, then began leading the next focus group sessions. Additionally, she met with Jonathan who mentored her as she developed an individually IRB approved study, "The Effects of Freedom on Creativity, Productivity, and Motivation" asking in part: what does freedom mean in studio settings and is there a difference between creative freedom in foundation versus advanced level courses?

Douglass and Zhao (2013) note that independent student research projects are a more reliable mechanism for student learning rather than just assisting faculty with their research projects.

Undergraduate research as a high-impact practice holds an important place at our institution (Kuh, 2008). Hayley's inquiry was based on the role of being an undergraduate researcher within the BFA program as she moved from foundation to upper division courses, while examining the role of creativity and freedom within the curriculum. With Hayley's preliminary study designed and in progress, she continued to meet and work with us on the focus groups which the results were presented at the 2018 ISSoTL Conference in Bergen, Norway (Fisher, J., Gregory, D. & Leavitt, H., 2018). At the conference, Hayley also presented a draft of her own study. With the valuable information she received following her conference presentation, she redesigned her study and began interviewing faculty as she matriculated through the program. In 2019, she submitted her pilot study results to the National Council on Undergraduate Research (NCUR) conference and was accepted. a We posit that research is assessed during the a/r/tography process. Like Irwin and Springgay (2008), we believe that "our actions, encounters, and thoughts – our living inquiry – as substance that can be arranged in discrete moments, counted, and subjected to normative evaluations, we need to understand living inquiry as responsibility" (p. xxxii). Working as a/r/tographers allowed us to reflectively and collaboratively develop research questions, collect data, and present "Influence Mapping The Four Ps of Creativity: Student Engagement, a/r/tography and SoTL", (Fisher, Gregory, & Leavitt, 2019) and "Students as SoTL Partners: How Reflective Practice Impacts Student Learning in Art and Design" (Fisher, Gregory, & Leavitt, 2019) at SoTL Commons and the Kennesaw State University Research on Teaching and Learning Summit conferences, respectively.

Irwin and Springgay describe a/r/tography as a methodology of embodiment, of continuous engagement with the world; one that interrogates yet celebrates meaning; it is a living practice; a life creating experience examining our personal, political and/or professional lives. As a qualitative inquiry method, the data can include interviews, journal writings of teachers or students, inquiry such as painting, photography, composing music/poems, narratives, or other forms of artistic inquiry. It is important to note the reflective/reflexive stance to analysis – it is ongoing and "may include aspects from traditional ethnographic forms of inquiry such as constantly comparing themes that emerge from the data" (p. xxix). A/r/tography allowed us to pay attention to the ongoing inquiry through an evolution of research questions and understandings. Rather than pursue a thesis with a/r/tography we pursued exegesis – a critical explanation of the meaning within a work . Our living inquiry provided opportunities for us to have conversations and relationships while paying attention to what we could see and know, and yet, to also pay attention to what is not seen and not known.

Conclusion

Hayley's final study was accepted to NCUR 2020. Over the course of three years, Hayley sought out and took advantage of mentorship and reflective practice paving a path to be an independent researcher as well as an equal partner with faculty members. In her own words:

> I see this experience as impacting my future role as an educator. I've asked questions that I hope to one day turn on myself in introspection and self-reflection. As other students learned about my experience, they too began to see that research within studio art is possible. This experience has opened the door for other students to become curious about research and be motivated to find the answers to their own questions (personal communication, 2020).

Her last sentence was particularly important to us. Mentoring other studio-based students for undergraduate research is our priority. In 2019 and 2020, two additional studio-art BFA candidates had projects accepted at NCUR. Through a/r/tography, we want to encourage and foster a culture of research within the school of art and design, particularly for studio-based faculty and students that may feel alienated from traditional quantitative research methodologies. In the arts, learning outcomes often exist in the form of storytelling, expressive personal narratives, and acknowledging divergent perspectives. Creativity can be inquiry. Like deFreitas (2007) we believe the primacy of the creative work in the research process validates the insight and learning artists and designers gain when they examine the creative process and the materiality of their work. Further, we also concur with Orr & Shreeve (2018) that learning outcomes (LOs) should offer signposts rather than a destination, and by embracing a degree of ambiguity or stickiness, LOs can support the development of creativity while allowing for diversity of output and differentiation. Leggo (2008) notes pedagogy is all about transformation, but that many of us do not live without the privilege of telling our stories or the privilege to be heard. Students as partners in art and design research may be an emerging field of inquiry. However, we believe a/r/tography aims to encourage artists/researcher/teachers in creative disciplines by allowing their stories to be told.

References

Angelo, T. (2012). Designing subjects for learning: Practical, research-based principles and guidelines. In Hunt, L. & Chalmers, D. (Eds.), *University Teaching in Focus: A Learning-centered Approach*. London: Routledge, 93-111.

Association of American Colleges and Universities (AAC&U). (2009). *Inquiry and analysis VALUE rubric*. Retrieved from https://www.aacu.org/value/rubrics/inquiry-analysis

de Freitas, N. (2007). Activating a research context in art and design practice. *International Journal for the Scholarship of Teaching and Learning (1)*2, Article 14. Available at: https://doi.org/10.20429/ijsotl.2007.010214

Douglass, J. A., Zhao, C.-M., & University of California, B. C. for S. in H. E. (2013). Undergraduate research engagement at major US research universities. Research & Occasional Paper Series: CSHE.14.13. In *Center for Studies in Higher Education.* Center for Studies in Higher Education.

Felten, P., Bagg, J., Bumbry, M., Hill, J., Hornsby, K., Pratt, M., Weller, S. (2013). A call for expanding inclusive student engagement in SoTL, *Teaching & Learning Inquiry, 1*(2), 63–74.

Fisher, J., Gregory, D. & Leavitt, H. (2018, October). *Constructing a learner's culture: Merging student voice, studio pedagogy, creativity, and SoTL.* Panel presented at International Society for the Scholarship of Teaching and Learning Conference, Bergen, Norway.

Fisher, J., Gregory, D. & Leavitt, H. (2019, January). *Influence mapping the 4P's of creativity: Studio engagement, a/r/tography, and SoTL.* Panel presented at SoTL Commons Conference, Savannah, GA.

Fisher, J., Gregory, D. & Leavitt, H. (2019, October). *Students as SoTL partners: How reflective practice impacts student learning in art and design.* Panel presentation at the Research on Teaching and Learning Summit, Kennesaw, GA.

Gregory, D., Fisher, J., Brasco, C., Robson, D., & Sipp, G. (2017, October). *SoTL contours in visual arts: Delineating an emerging future.* Panel presented at International Society of the Scholarship of Teaching and Learning Conference, Calgary, Canada.

Irwin, R. (2008). Communities of a/r/tographic practice. In Stephanie Springgay, Rita Irwin, Carl Leggo, & Peter Gouzouasis (Eds.) *Being with a/r/tography*, Rotterdam: Sense.

Irwin, R. (2013). Becoming A/r/tography. *Studies in Art Education: A Journal of issues and Research, 54*(3), 198-215.

Irwin, R., & Springgay, S. (2008) A/r/tography as practice-based research. In Stephanie Springgay, Rita Irwin, Carl Leggo, & Peter Gouzouasis (Eds.) *Being with A/r/tography*, Rotterdam: Sense.

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.

Leggo, C. (2008). Autobiography: Researching our lives and living our research, in Stephanie Springgay, Rita Irwin, Carl Leggo, and Peter Gouzouasis (Eds.), *Being with A/r/tography*. Rotterdam: Sense.

Nagle, B. & Willimas, N. *Methodology Brief: Introduction to Focus Groups*. Retrieved online on July 15, 2018: http://www.mmgconnect.com/projects/userfiles/File/FocusGroupBrief.pdf

National Association of Schools of Art and Design Handbook (2019-2020). Retrieved online on March 15, 2020: https://nasad.arts-accredit.org/wp content/uploads/sites/3/2019/12/NASAD-Handbook-2019-20.pdf

O'Brien, M. (2008). "Navigating the SoTL landscape: A compass, map and some tools for getting started." *International Journal for the Scholarship of Teaching and Learning, 2*(2), Article 15. Available at: https://doi.org/10.20429/ijsotl.2008.020215

Orr, S., & Shreeve, A. (2018). Ambiguity and uncertainty in creative education. In *Art and Design Pedagogy in Higher Education: Knowledge, values and ambiguity in the creative curriculum,* Orr, S. & Shreeve, A. (Eds.). New York: Routledge.

Richards, R. (2007). *Everyday creativity: And new views of human nature, psychological, social, and spiritual perspectives*. Washington, D.C.: APA. Online: www.apa/org/books/

Sawyer, R. K. (2012). *Explaining creativity: The science of human innovation* (2nd Ed). Oxford and New York: Oxford.

Shreeve, A, Warening, S. & Drew, L. (2009). Key aspects of teaching and learning in visual arts. In H. Fry, S. Ketteridge & S. Marshall (Eds.), *A handbook for teaching and learning in higher education: Enhancing academic practice*. New York and London: Routledge.

Shulman, L. (2005). Signature pedagogies in the professions. *Daedlus, 134*:3, 52-59. Available at: http://www.jstor.org/stable/20027998

Sword, H. (2019). The first person. *Teaching and Learning Inquiry, 7*(1). Available at: http://dx.doi.org/10.20343/teachlearninqu.7.1.12

Winters, T. (November-December, 2015). *Facilitating early research experience in art and design using a research-oriented approach to teaching and learning.* Paper presented at the Annual Meeting of the Australian Association for Research in Education, Freemantle, Western Australia (ED593810).

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).

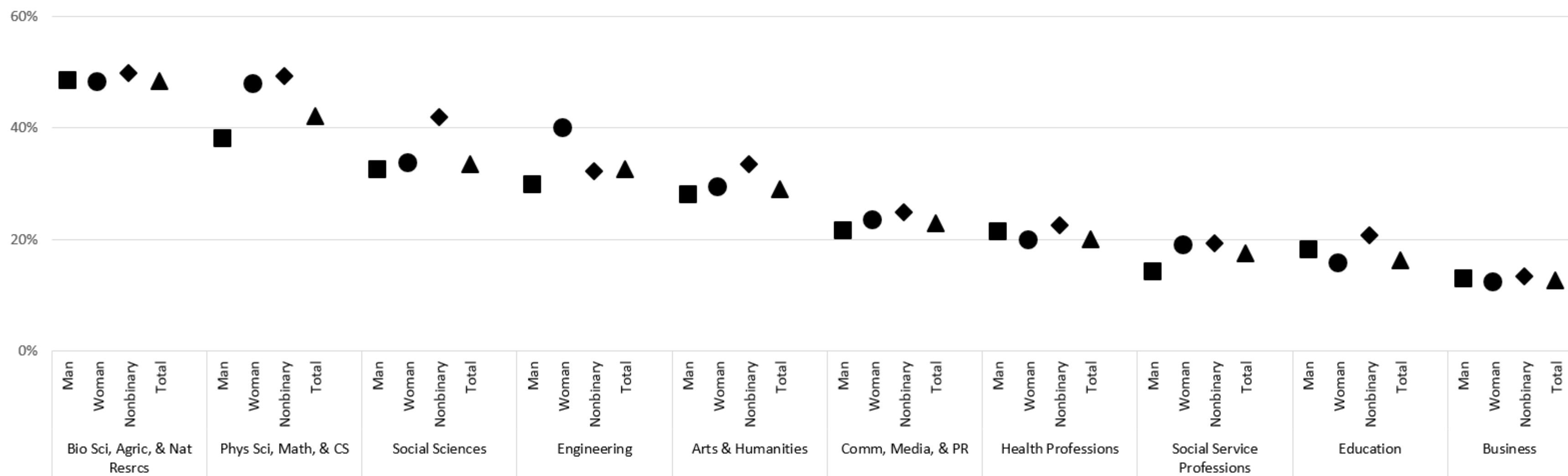

Figure 1. Senior undergraduate research participation by major field and gender identity. Bio sci =Biological science; Agric = agriculture; Nat resrcs = natural resources; Phys sci = physical sciences; CS = computer science; Comm = communications; PR = public relations.

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).

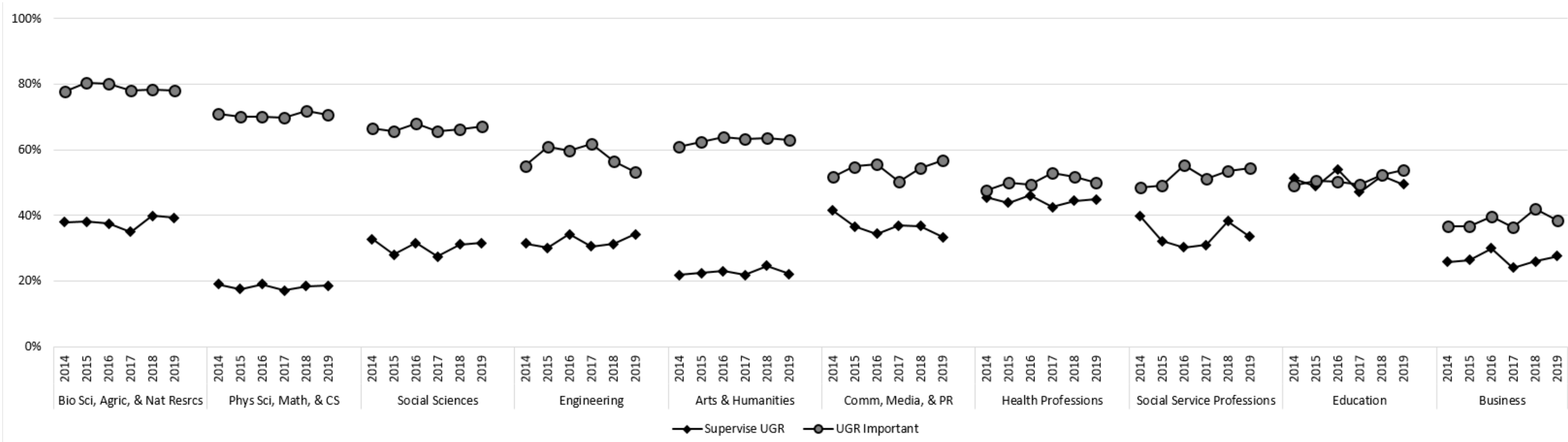

Figure 2. Faculty participation in and importance (*Very important* or *Important*) of undergraduate research (UGR) over time by disciplinary area. Bio sci =Biological science; Agric = agriculture; Nat resrcs = natural resources; Phys sci = physical sciences; CS = computer science; Comm = communications;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

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 57-71.
doi: 10.14434/josotl.v21i1.30660

Leveling Up an Award-Winning Undergraduate Research Program: A Case Study From Furman University

Beth Pontari
Furman University
beth.pontari@furman.edu

Erik Ching
Furman University

Suzanne Klonis
Furman University

Diane E. Boyd
Furman University

Abstract: This case study delineates the process that a small, private liberal arts university employed to amplify its high-impact practices in an already award-winning undergraduate research (UR) program. The process was catalyzed by combined institutional factors: the start of a new accreditation cycle and the launch of our university's strategic vision, The Furman Advantage (TFA). Established in 2016–2017, TFA ensures all students have access to a high-impact engaged learning experience—UR, study away, and/or an internship. This institutional imperative provided an opportunity to assess the degree to which Furman's UR program was meeting high-impact criteria. We compared Furman's summer UR program against the emerging research on high-impact practices and made changes to enhance learning and to close equity gaps in access. We reoriented our UR program to focus on the characteristics of high-impact practices, particularly the mentoring relationship between faculty and students and the importance of student self-reflection. We reviewed improvements to our summer fellowship program, namely, changes in the application and review process, professional development for faculty, pre-experience training for summer research fellows, and modifications to our survey and self-analysis instruments. Broader programmatic changes included articulating common learning outcomes for engaged learning experiences and creating an evidence-driven assessment mechanism to help us meet learning outcomes and institutional objectives. Implementation of these changes required sustained collaboration at the institutional level between the Offices of Undergraduate Research, the Center for Engaged Learning, the Office of Institutional Research and Assessment, and the Faculty Development Center. In addition to measuring changes within UR over time, we have also been able to make comparisons across different engaged learning experiences, principally study away and internships, and then use this data to continue TFA improvements. Preliminary findings indicate that we have successfully enhanced our implementation of high-impact practices.

Keywords: undergraduate research, high impact practices, engaged learning, assessment, mentorship.

History and Background of Undergraduate Research and Engaged Learning at Furman

Collaborative research between faculty and students has a long history at Furman University, a small, private liberal arts university located in Greenville, South Carolina. The first faculty and student copublication appeared in a chemistry journal in 1932. This dedication to engaging students outside of the classroom was promoted for decades but was formalized in 1966 when the chemistry department created a program to enable its majors to conduct summer research collaboratively with faculty. Since that time, the summer research program has grown considerably. In a typical summer, over 200 students conduct research with approximately 90 faculty from all disciplines across the university. The student–faculty collaborative teams engage in the examination, creation, and sharing of new knowledge in all disciplines—whether it be via laboratory research in the sciences, text-based research in the humanities, field research in the natural and social sciences, or creative projects in the fine arts and humanities. Undergraduate research (UR) is also fully incorporated into the curriculum. All academic departments have a combination of a methods course and a senior seminar or other capstone project that involves a significant research or creative project component. Further demonstrating its commitment to student research and the importance of sharing scholarly work publicly, the Office of Undergraduate Research (OUR) provides travel subsidies to send students to professional conferences and academic competitions. On average, over the last 3 years, the office has funded approximately 120 students to present the results of their scholarship in over 25 different discipline-specific regional, national, and international conferences.

Furman has also taken seriously the assessment and refinement of its UR program. In 2005, we secured a Teagle Foundation grant for a 3-year project to study the value that undergraduate research adds to a liberal arts education. Surveys of seniors in 2006 and 2007 revealed that those who had participated in UR demonstrated more intellectual confidence in problem solving, scientific thinking, and quantitative skills; more satisfaction with their relationships with faculty and their undergraduate education; and a higher perceived value of engaged learning than those who did not participate in research. This long-standing commitment to broad excellence in UR was honored in 2016 when Furman received the Council on Undergraduate Research Campus-Wide Award for Undergraduate Research Accomplishments (or AURA).

These UR efforts are part of a broader investment in engaged learning and high-impact practices (HIPs) evidenced through our leadership and record of awards. President David Shi, in his 1994 inaugural address, "An Engaged Approach to Liberal Learning," captured Furman's enduring dedication to active and immersive learning inside and outside the classroom. In 1996, Furman received a grant from the Christian A. Johnson Endeavor Foundation to promote the university as "a community of engaged learning." In 2003, Furman appeared among the top five in the *U.S. News and World Report* rankings of teaching through active learning. In 2016, Furman reaffirmed its commitment to engaged learning when it launched its strategic vision, The Furman Advantage (TFA), which promises all students access to engaged learning experiences (ELEs), specifically UR, internships, study away, and community engaged learning opportunities. Indeed, in spring 2018, when Furman completed its reaccreditation process with the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC), it chose a quality enhancement plan (QEP) that is a natural extension of this decades-long history of engaged learning. The QEP is a focused plan intended to improve "specific student learning outcomes and/or student success," and "is derived from an institution's ongoing comprehensive planning and evaluation processes" (Southern Association of Colleges and Schools Commission on Colleges [SACSCOC] Principles of Accreditation, Standard 7.2, 2018). Furman defined the goals of its QEP to ensure that (1) all students have at least one of the following experiences: UR, internship, or study away; and (2) these experiences are high quality and impactful. This plan centered on removing barriers to participation (e.g., financial, time) as well as creating a robust assessment of experiences that included both quantitative measures and reflections. Much of the assessment of UR we describe in this article measures the goals and learning objectives set forth in the QEP and the promises made to students in TFA.

In short, TFA and the QEP afforded a new lens through which to refine and execute engaged learning, including UR. Furman re-envisioned its engaged learning program to be housed in the Center for Engaged Learning (CEL) and added an administrative position, the associate provost for engaged learning, to oversee it. This restructuring not only centralized space and logistics, allowing us to better track student participation and meet our "every-student promise," but also encouraged each office within the CEL to find common ground, namely, around the characteristics of HIPs.

Focusing on the HIPs literature promoted the student-centeredness necessary to improve upon our already robust UR program. Nonetheless, while HIPs show promise for creating equitable learning experiences for students, the unevenness with which some of their components (active learning, institutional commitment to structural support of HIPs) are implemented make scaling up challenging (Kuh, 2008; Kuh, O'Donnell, & Reed, 2013). For example, while we know that UR, now one of *11* HIPs, promotes student self-efficacy, disciplinary knowledge, and research skills, and critical thinking (Linn, Palmer, Baranger, Gerard, & Stone, 2015; Kilgo, C. A., Sheets, E., & Pascarella, E. T., 2015: Lopatto, 2006), we also know that, historically, underrepresented students are less likely to engage in UR (Finley & McNair, 2013; Finley, 2019; O'Donnell, Botelho, Brown, González, & Head , 2015; Shanahan, 2017). The recognition of these disparities in student participation spurred a national conversation about making HIPs, and UR specifically, more student centered (Kinzie & Zilvinskis, 2016). To address this issue, Furman opted to reorient its UR program toward mentorship, in part because of the mutual benefits of mentoring reported by faculty and students: Faculty saw gains in research and satisfaction in helping students develop, and students perceived gains in developing a scholarly identity (Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E., 2015; Potter, S. J., Abrams, E., Townson, L., & Williams, J. E., 2009). especially at a small liberal arts college, where mentorship is structured by faculty rather than graduate students (Behar-Horenstein, L. S., Roberts, K. W., & Dix, A. C., 2010). Centering the mentoring relationship resulted in, but was not limited to, the following changes: amending the application for both mentors and mentees; revising the criteria employed by the summer research faculty-review committee; educating mentors on HIPs; creating a common language around the characteristics and assessment of high-impact experiences; introducing a mandatory training and enhancement program for the summer research fellows and changing the survey and self-reflection instruments that they are required to complete; and creating an evidence-driven assessment mechanism that allows us to determine if we are meeting our objectives. We describe each of these in more detail below.

Leveling Up Furman's UR Program: Application, Review Process, Funding, Student Engagement

We refer to our goal of improving the student research experience and assessing our progress along the way as "leveling up." We set out to increase quality, enhance access, and use data to make programmatic changes. One of our main leveling-up strategies was to place the mentoring relationship at the center of our initiatives.

Application Changes

Although many faculty and students collaborate on UR projects during the academic year, we focus here on our summer research program. Changes to the application and review process offer a clear example of our shifting priorities toward mentoring and the characteristics of HIPs. Previously, our application process focused on the faculty member's project and its merits as measured against leading scholarship in the field. The review committee consisted of as many as 10 faculty members from across campus representing the four academic divisions (humanities, fine arts, social sciences, and natural sciences). The construction of the committee was designed to ensure that one or more experts in an associated field would assess every application. The committee functioned, essentially, as a grant-providing agency. It had a defined budget and an excess of applications, so its goal was to determine which projects merited funding. The main standards for award were the project's prospect to advance scholarship and the faculty member's accomplishments in research and publication.

Notably absent from the application were questions related to mentorship and other features of HIPs, in regard to either the faculty members' ability to provide evidence of quality mentorship in the past or their intended approach to mentoring their current research fellows. Regardless, and much to the credit of Furman's faculty members, high-quality mentorship occurred, as evidenced by the number of awards our students received for conference presentations, the number of joint publications between students and faculty and Furman's receipt of the Council on Undergraduate Research's AURA in 2016.

The convergence of the QEP, TFA, and the hiring of new administrative personnel (a new director of undergraduate research and the new associate provost for engaged learning) provided the opportunity to assess the intended outcomes of our summer research program and to amend the application and review process accordingly. In the first year (2018), we retained much of the application content as it existed but added a series of seven questions related to HIPs and the faculty applicant's intention to meet their criteria (See Table 1).

Table 1. Furman undergraduate research faculty application questions.

HIP characteristic	Item used to assess characteristic
Preparation	Describe the types of preparatory work (e.g., training, describing experience timeline, etc.) the fellow(s) will do before or at the beginning of the experience to ensure they get the most out of it. Be sure to include how you will make student-learning outcomes clear to the participant(s).
Relationships	Describe how this experience will help the fellow(s) build substantive (ongoing, meaningful) relationships, e.g., with faculty, staff, mentors/supervisor(s), peers, community members, etc. Also describe any opportunities the fellow(s) will have to collaborate with these parties.
Diversity	Describe how this experience will facilitate the fellow(s)' engagement across differences, through contact with people with different ideas, backgrounds, and experiences.
Feedback	Describe how you will provide the fellow(s) with feedback about their performance, including the frequency and level of detail and formality of the feedback. Will you give the fellow(s) the opportunity to make changes/adjustments based on the feedback you provide?
Real-world application	Describe how the fellow(s) will apply, integrate, and synthesize knowledge in the context of this experience. Will they have the opportunity to apply their knowledge to a novel problem or setting, and if so, please describe.
Reflection	Describe how you will ask the fellow(s) to reflect on their learning and development, including the frequency, format (e.g., video diary, journal, etc.), and topic (e.g., problems encountered, how problems were dealt with, connection to academic work, knowledge/skills gained, etc.) of these reflections.
Presentations	Describe the frequency and format of oral presentations (formal and informal) you will expect your fellow(s) to make about their experience and/or knowledge they have gained. At the minimum this would include presenting at Furman Engaged Day on Tuesday April X, 20XX.

Note. HIP = High-impact practice.

The new questions were designed broadly on conversations by several Furman faculty and staff (described in a later section), the work of George Kuh, among other scholars, and noted later, reflection questions asked of students before and after their UR experience (Kuh 2008; Kuh et al., 2013). Of course, we could not assume that every prospective faculty mentor was familiar with said scholarship, so this change to the application was preceded by outreach. The outreach efforts included but were not limited to focusing the preceding annual faculty fall retreat on ELEs and HIPs; integrating summary descriptions of HIPs into the application process and requiring both faculty and student applicants to read them before completing their applications; and holding targeted meetings by the director of undergraduate research with prospective faculty mentors, especially in disciplines comparatively underrepresented in summer research, for example, the humanities and fine arts.

Application Review Process and Funding Changes

In the 1st year of the transition, members of the review committee retained the traditional scholarship standards of the past but also considered the applicants' responses to these new items. Furthermore, they focused less on reasons to deny an applicant and instead provided constructive feedback such that in a revise-and-resubmit process (newly introduced), a slightly subpar application might raise itself to the high standards of approval. In short, the review process became more of an educational process to instruct our campus community on mentorship and HIPs. To acknowledge faculty effort in addressing these areas and the carefulness with which they responded to these items, once a faculty member's responses to the HIP questions are approved, they only have to complete them once every 3 years.

This transition to focusing on providing feedback and not denying funding requests was facilitated by an infusion of extramural funds from the Duke Endowment as part of TFA. We found ourselves in the privileged position of potentially funding any application that rose to the merit of approval, rather than looking for reasons to deny applications due to a lack of funding. Regardless, even if that infusion of funding had not existed, we were shifting our priorities and our campus community's consciousness and culture toward mentorship and HIPs. While not abandoning standards of scholarship, we were trusting faculty members, and the departments who hire them and evaluate them for promotion, to serve as the arbiters of scholarship.

In the 2nd year (2019) of the revised application and review process, we made additional changes that further emphasized mentorship and HIPs. We reduced the questions relating to scholarship on the faculty application to a single 250-word summary and instead relied on the faculty members' curriculum vitae to provide evidence of their ability to contribute to their respective field. In the 3rd year (2020), we eliminated the curriculum vitae requirement and instead introduced new questions on the student portion of the application that related to the project's content and its potential to make an original contribution. We presumed that the student fellows could answer those questions only after consulting with their faculty mentors, so our intention was to create infrastructural conditions that would promote mentorship.

Student Engagement

Prior to these various transitions, the level of direct contact between the OUR and the various summer research fellows was rather limited. The primary point of contact for fellows was their respective faculty mentor. We introduced a few modest but substantive requirements into the fellowship program aimed to prime students for reflection. First, we changed the April contract-signing meetings to emphasize HIPs. All summer research fellows are required to gather in a room together with the director of undergraduate research to sign their contracts. We retained this tradition for practical purposes, but we shifted the purpose of the meeting toward introducing the students to self-reflection practices and career competencies, such as those outlined by the National Association of Colleges and Employers (NACE).

We built upon these changes to the contract-signing meetings by creating a new training/enhancement program that required every summer research fellow to attend three 1-hr sessions that focused on strategies of self-reflection and recognizing the ways in which a summer research experience would contribute to the fellows' growth beyond disciplinary confines. The third of these three sessions consisted of the fellows being divided into interdisciplinary subgroups of 10 each and then describing the ways in which their project enhanced their career competencies in a 4-min "'elevator pitch." Anecdotal evidence suggests that these interventions succeeded in reframing the students' approach. At the very least, compared to prior years' research fellows, they were able to describe their research experience in broader and more diversified ways, which we believe will enhance their ability to make their research experience more relevant in job interviews and graduate school applications.

We also looked for ways to celebrate mentorship and reinforce best practices, without imposing on faculty members' time or academic freedom. One method was to establish a Faculty Mentors' Appreciation Luncheon. During this luncheon, we recognize accomplishments in mentoring during the prior year, such as faculty and student awards and joint publications, and high-level administrators extend their appreciation to the mentors for their efforts. A faculty member with a proven record of high-quality mentoring also gives a keynote address.

As we have refocused our summer UR program on mentoring students, the number of summer research fellows has grown steadily over the past 4 years (see Table 2). In 2020, our growth would have been exponential had it not been for the COVID-19 pandemic, which forced Furman to close its campus for the summer and allowed us to fund only those projects that could convert to an entirely remote format. We still had a substantive increase of 32 projects from 2019, even though 46 projects had to be canceled owing to the pandemic.

The faculty in Table 2 represent each of our university's academic divisions. During this 4-year period, on average 60% of projects came from the natural sciences, 20% from the arts and humanities, and 20% from the social sciences. Every one of our 26 academic departments hosted at least one UR project in each of those years.

Table 2. Number of summer research fellows and faculty mentors, Furman University, 2017–2020.

Year	No. of summer research fellows	No. of faculty mentors
2017	170	80
2018	190	88
2019	203	89
2020	232	104

Note. Furman averaged 2,656 students and 243 faculty during this period. For the years 2017–2020, student participation was approximately 7.5%; faculty participation was 37%.

Various factors account for the steady growth shown in Table 2, not the least of which is ample funding. But previously, one of the main hindrances to growth in UR was the number of faculty members willing and able to take on summer research fellows. The increase in the number of faculty mentors is perhaps the most striking aspect of Table 2. It reflects, among other things, an institutional commitment to and culture of providing students with HIPs as part of TFA. As just one small but representative example, nontenured faculty members account for much of the increase in fellows, likely because prospective faculty members are asked during their job interviews about their ability to incorporate students into research projects. For ease, we summarize the changes made to our UR program in Table 3.

Table 3. Summary of undergraduate research program changes at Furman University, 2015–2020.

Type of change	Year of implementation			
	Pre-2018	2018	2019	2020
Application focus and changes	Faculty research focus, along with questions regarding expertise	Mentorship; HIP questions added	Reduced faculty research section to 250 words; CV consulted to replace expertise questions	CV eliminated; student application includes questions on the project's originality and contribution to science (preconversation between mentor/mentee)
Funding	Budget limit; awarded on academic merit	Budget expanded to fund as many mentorship-rich applications as submitted	Funding remains available for mentorship-rich applications	Program funding doubles from 2018 levels
Review Process + Feedback	Review committee of about 10 faculty members representing 4 academic divisions; applications reviewed by content "experts"	Revise and resubmit process focused on feedback for improvement		
Student development; contact w/Office of Undergraduate Research	At the department or individual faculty level; limited	Contract-signing meeting's focus shifted to HIPs	Students attend 3 1-hr workshops on reflection, experience articulation, consolidating experience into "elevator pitch"	

Note. CV = Curriculum vitae; HIPs = high-impact practices.

Although we have increased student participation in summer research, one issue facing many UR programs is participation by underrepresented students, and Furman is no exception, despite our efforts to ensure that all students have access to HIPs. Traditionally the Furman mentor–mentee relationship is established through informal mechanisms or interpersonal relations established during the academic year. Reliance on these methods can hinder access for some students, especially those traditionally underrepresented. We attempted to rectify this by creating a central place—a link on the UR website—where faculty mentors who had a project, but not yet an established fellow, could advertise their availability. Participation in the 1st year was modest—only 10 of more than 100 mentors—but it is a start.

The sum of these changes is that an already strong UR program has become even more robust in a relatively short period of time, in part because of the focus on HIP alignment, detailed above and in Table 3. An unexpected benefit of shifting our focus to HIPs and centering on the mentor relationship is that our faculty were primed to respond with agility to the COVID-19 pandemic. Indeed, most faculty mentors revised their original projects—in some cases to areas outside their expertise—to provide a remote experience for their students. Anecdotal evidence indicates that a portion of those mentors would have canceled their summer research program if their sole focus had been their own research agenda, but because the student experience took precedence, they made the pivot. To facilitate this process, the Faculty Development Center provided support workshops in April, May, and June 2020 to help faculty envision conducting research remotely for Summer 2020; 42 faculty participated in them.

Ironically, the pandemic provided us with the opportunity to become more proactive about tracking mentoring and encouraging best practices. For example, the OUR distributed a survey to all the faculty mentors asking them to describe their research plans, including any particular professional strengths they possessed that they would be willing to share with colleagues, and any training needs they might have as a result of taking on a research program outside their area of expertise. The results of the survey were shared with all mentors. The objective was to encourage collaboration among faculty mentors. Indeed, in addition to reports of numerous faculty mentors reaching out to one another regarding research methodologies and mentoring strategies, often across disciplinary lines, we saw the emergence of some cross-disciplinary research communities, in which student researchers collaborated and reported out to one another. The qualitative-research group, for example, included faculty and students from mathematics, modern languages, sociology, sustainability studies, and the Faculty Development Center. One outgrowth of these activities was a professional development webinar, cohosted with neighboring Wofford College, entitled, "How the COVID-19 Pandemic Made Me a Better Research Mentor." Eight research mentors shared vignettes of new mentoring strategies they adopted as a consequence of shifting to virtual projects, and then, notably, which ones they intend to retain even after they are able to return to in-person mentoring.

While the pandemic was costly, our end-of-summer-student surveys reveal that the high quality of our faculty mentoring was not only retained but even improved in key areas. For example, in response to the question, "How often did you receive substantive feedback (either in-person or virtual) from your faculty mentor?" the percentage of students responding with "very often" increased from 72% in 2019 to 82% in 2020. And similarly, in response to the prompt, "The preparation for this experience from my faculty mentor...," the percentage of students responding with "was about right" increased from 82% in 2019 to 91% in 2020. While various factors might account for these improvements amidst the pandemic, we like to think that our efforts to "center mentoring" in our leveling-up activities bear some responsibility.

Ensuring Access and Impact

How We Count and Track UR Experiences

Not only have we shifted the UR culture to integrate student-centeredness and HIPs, but also we have redesigned the way we assess experiences by "hearing" students and making programmatic changes. A first step is to accurately identify which students engage in HIPs. The CEL, in partnership with the Office of Institutional Assessment and Research, created a tracking system that involves several data collection points (see Table 1 for these data). For UR, tracked experiences include semester credit-bearing (e.g., senior thesis) and full-time summer experiences that are vetted by the CEL and described in the section above. On a senior survey completed right before graduation (averaging an 87% response rate), students also self-report whether or not (and when) they had an ELE (including a summer or academic year UR experience). Finally, students (except for 1st-year students) complete an engaged learning checklist during their fall meetings with their academic advisors. Using a comprehensive list of possible experiences, advisors and students discuss (and check off) which ELEs the student had during the previous academic year and summer (including UR). These forms have a response rate of approximately 54% and are submitted to the CEL. Student self-reports via the senior survey and the checklist data allow us to triangulate on experiences and check to ensure the accuracy of our tracking data and methodology. Throughout the assessment portion, unless otherwise indicated, we report data on UR (and other ELEs) based on tracking data. As depicted in Table 4, tracking data is a more conservative approach to counting ELEs.

Table 4. Comparison of undergraduate research participation by counting method.

Counting method	Graduating class			
	Class of 2016	Class of 2018	Class of 2019	Class of 2020
Tracking[a] (vetted experiences)	22%	29%	32%	33%
Senior survey self-report	28%	44%	39%	39%

Note. Class of 2017 is not included because the senior survey was not administered that year.
[a]Tracked experiences rely on data from transcripts and participation data from the Center for Engaged Learning, thereby making these data more reliable in terms of the nature and quality of the experience. We use the discrepancies in self-report and tracking data to refine and check our tracking system. We do not report the engaged learning checklist data here because of the low response rate. Those data are similarly used to refine and check our tracking system.

Overview of Our Assessment Plan

Our assessment plan (which addresses the outcomes we proposed to monitor and improve upon in our QEP), includes measuring (1) student perceptions of how well their experience aligned with the characteristics of HIPs, (2) the impact of the experience, based on students' expectations before and perceptions after the experience, as well as a postexperience reflection, and (3) postgraduation outcomes such as having a job at graduation or being enrolled in postgraduate study. Including these diverse constructs as well as assessment types provides a robust, evidence-based, student-centered approach to continue to improve upon our UR program. Furthermore, both the quantitative and the qualitative aspects of our assessment process foster student reflection, thereby enhancing students' tendency to think critically about their experience.

Although it may be the case that certain types of students pursue UR experiences and thus assessing the impact on those students provides a biased or perhaps inflated view of the impact of UR, below we compare key UR outcomes to outcomes for students who had internships and other ELEs, putting these data into a broader context. Furthermore, for those that do have a summer UR experience, we have several mechanisms in place to ensure a high response rate. For example, students receiving summer research fellowships and/or those who choose to document their ELE on their official transcript as a zero-credit course are required to complete a presurvey, a postsurvey, and a written reflection about their experience.

Assessment of How Well UR Experiences Conform to Furman HIPs or Engaged Learning Characteristics

The postsurvey asks students whether the experience conformed to Furman-defined characteristics of HIPs. We determined these characteristics by consulting the literature on HIPS (Kuh, 2008; Kuh et al., 2013), experiential learning (Evans, Forney, Guido, Patton, & Renn, 2010; Kolb, Boyatzis, & Mainemelis, 2001), and applied learning (National Society for Experiential Education, 1998)—note, these characteristics match the questions in Table 1 used for summer research applications. Although these different categories of immersive learning overlap more than they differ, they use different labels to represent similar concepts (e.g., monitoring experiences vs. receiving substantive feedback), they emphasize different elements of the experience (e.g., interaction with diverse groups or ideas), and some have unique features (e.g., applied learning includes authenticity as a key element; the others do not). Using this information, a committee of faculty and staff, as well as a team that attended the Association of American Colleges and Universities' HIP Institute, contributed to the discussion and final determination of HIP characteristics that best fit with the goals and learning objectives outlined in the QEP. These were shared with faculty and staff in various forums to obtain feedback.

These characteristics and the items used to assess them are presented in Table 5. A large percentage of students report their mentor prepared them for the experience and gave the right amount of feedback to allow them to make changes and improve—which suggests that faculty are engaged in the mentoring process. Indeed, the results of a simple linear regression show that on the senior survey, participation in UR positively predicted students' responses to the question, "At Furman, I had a mentor who encouraged me to pursue my goals and dreams" (rated on a 1 to 5 scale from *strongly disagree* to *strongly agree* (R^2 = .02, F(1,500) = 10.07, p < .01). The number of reported undergraduate research experiences significantly predicted mentorship (β = .13, 95% confidence interval [.048, .205], p < .01). These data also show areas for improvement, including incorporating more reflection during their experience. Note that students having summer UR experiences were required to reflect at the completion of their experience as part of our effort to incorporate reflection systematically into ELEs. Furthermore, because we use the same assessment for all ELEs, we can compare UR experiences with other ELEs to provide more context (as presented in Table 5). In sum, measuring how students perceive the presence or absence of Furman-valued characteristics of HIPs provided a way to check if our efforts to move UR to a more student-centered approach is working and focused our efforts on professional development for both faculty and students.

Table 5. Student perceptions of the presence of HIP characteristics in their ELE.

HIP characteristics	Engaged learning experience			
	Research (*n* = 169–392)	Study away (*n* = 91–556)	Internship (*n* = 188–386)	Writing seminar (*n* = 49–261)
Time				
How many hours a week did you spend on this experience? (% 20+ hours) [a]	86% $_{ab}$	93% $_{a}$	82% $_{b}$	4% $_{c}$
The duration of the experience (% "was about right") [b]	80% $_{a}$	73% $_{a}$	84% $_{a}$	84% $_{a}$
Preparation				
The preparation for this experience from my supervisor/faculty mentor (% "was about right") [c]	82% $_{a}$	70% $_{a}$	88% $_{a}$	88% $_{a}$
Interaction				
How much interaction (collaboration, discussion, etc.) did you have with your supervisor/faculty mentor? (% "a lot") [d]	59% $_{a}$	69% $_{a}$	69% $_{a}$	52% $_{a}$
Diversity				
Exposure to new ways of thinking ("was about right") [c]	92% $_{a}$	93% $_{a}$	93% $_{a}$	84% $_{a}$
My interactions with non Furman people were (% "meaningful"/"very meaningful"/"life-changing") [e]	84% $_{a}$	86% $_{a}$	96% $_{b}$	64% $_{c}$
Feedback				
How often did you receive substantive feedback from your supervisor/faculty mentor? (% "very often") [f]	69% $_{a}$	53% $_{b}$	55% $_{b}$	60% $_{ab}$
I was able improve my work based on the feedback I received (% "somewhat"/"strongly agree") [g]	97% $_{a}$	64% $_{b}$	87% $_{a}$	92% $_{a}$
The feedback I received (% "was about right") [c]	87% $_{a}$	75% $_{b}$	79% $_{ab}$	74% $_{ab}$
Real-world application				
The application of relevant course work (% "was about right") [c]	92% $_{a}$	83% $_{b}$	77% $_{b}$	80% $_{b}$
Reflections				
How often were you asked to write reflections on your learning and development? (% "weekly or daily") [h]	29% $_{a}$	52% $_{b}$	79% $_{c}$	48% $_{ab}$

Note : Percentages with different subscripts differ based on 99% confidence intervals. HIP = High-impact practice; ELE = engaged learning experience.

[a] Scale: Fewer than 10 hr a week; 10–19 hr a week; 20–30 hr a week; more than 30 hours a week.

[b] Scale: Was far too short; was too short; was about right; was too long; was far too long.

[c] Scale: Was far too little; was too little; was about right; was too much; was far too much.

[d] Scale: None at all; a little; a moderate amount; a lot.

[e] Scale: Were not at all meaningful; were only somewhat meaningful; were meaninful; were very meaningful; were life-changing.

[f] Scale: Never; rarely; sometimes; very often.

[g] Scale: Strongly disagree; somewhat disagree; neither agree nor disagree; somewhat agree; strongly agree.

[h] Scale: Never, monthly, weekly, daily.

Assessment of Impact

Self-report. In addition to understanding how students perceive factors such as engagement of their mentor or helpfulness of feedback, we also assessed their perception of the impact the experience had on them. The survey described above asks students to self-report what level of impact their research experience had on their future plans. This assessment is unique in that it asks students in the presurvey to reflect on and indicate what level of impact they expect the experience to have on a scale from 1 (*little or no anticipated impact*) to 4 (*life-changing impact*). When students complete the postsurvey, their pretest responses are presented back to them with the following question, "Before this ELE started, we asked you about the level of impact you expected this experience to have on you or your future plans. You indicated X. Now that you've completed the ELE, what level of impact do you think it had?" The majority of students indicated before their UR experience that it would have moderate to high impact and the majority (57%) reported the experience met those expectations; 25% reported their UR experience had a higher level of impact, while 17% chose a lower level, which is about the same as the other experiences cataloged. To reliably examine the presurvey versus postsurvey impact data and compare UR to other ELEs, as well as to examine if the characteristic of HIPs reported in Table 5 predict UR impact, we needed to collect more data. One challenge of this analysis strategy is that it requires student responses for the pre- and postassessment. Below, we report more impact data but only for the postassessment, for which we have more responses.

In the postsurvey, we also asked students how much the experience changed their worldview, to what extent it allowed them to apply what they learned in the classroom, and how much it influenced their career plans. See Table 6 for the results on these items and how they compare to students' reactions to internship, study away, and 1st-year writing seminar experiences. These results suggest that impact is not a singular construct and that each kind of ELE may have a unique kind of impact on students. For UR, these data, taken together with the data on reflection in Table 5, may indicate that we could be more intentional about having students reflect on how their research fits into a broader context, and how their experience can influence their perception of their place in the world, regardless of the content of their research.

Table 6. Postsurvey self-report of impact.

Impact items	Engaged learning experience			
	Research (n = 177–312)	Study away (n = 184–307)	Internship (n = 202–219)	Writing seminar (n = 80–139)
What level of impact did this experience have on your and/or your future plans? (% "high impact"/"life-changing impact") [a]	76% $_a$	83% $_a$	85% $_a$	26% $_b$
How much has this experience changed your worldview? (% "some"/"completely") [b]	69% $_a$	90% $_b$	86% $_b$	53% $_a$
How much did this experience allow you to apply what you've learned in the classroom? (% "some"/"completely") [b]	93% $_a$	83% $_a$	84% $_a$	83% $_a$
How much did this experience influence what you wanted to do in your career? (% "some"/" a lot") [b]	83% $_a$	67% $_b$	92% $_a$	28% $_c$

Note: Comparison across ELE types used 99% confidence intervals.

[a] Scale: Little or no impact; moderate impact; high impact; life-changing impact.

[b] Scale: Not at all; only a little; some; completely /a lot.

Impact on careers and transition to life after college—First destinations and clearinghouse data. In addition to using student self-reports about their experience to assess the impact of UR, as part of Furman's QEP, we proposed that ELEs should impact postgraduate plans, providing a concrete measure of impact. Here, we include preliminary results that show that students who participate in UR are more likely to pursue postgraduate education. Data for the graduating classes of 2018 and 2019 were compiled by comparing self-reported postgraduate plans on Furman's senior survey; the First

Destinations Survey, which is completed 6 months after graduation; the National Student Clearinghouse records; which indicate subsequent enrollment at another institution of higher education; and LinkedIn records where available. This multidata approach should provide an accurate representation of postgraduate outcomes often absent from other articles reporting similar outcomes (see Table 7 for a summary).

Table 7. Postgraduate outcomes by ELE participation (based on tracking data)

Postgraduation outcome	Engaged learning experience			
	Research (*n* = 360)	Study away (*n* = 624)	Internship (*n* = 618)	None (*n* = 204)
Continuing education	52%	39%	41%	31%
Employed	31%	42%	43%	43%
Military, volunteer, or employed PT	6%	6%	3%	5%
Not employed (seeking/not seeking)	4%	5%	5%	6%
Unknown	8%	9%	7%	15%

Note : PT = Part-time.

Table 7 shows that students who participated in at least one research experience were more likely to continue their studies (in graduate, medical, or law school) than graduates who had study away or internship experiences, but they were less likely to pursue employment. Note that students could be included in more than one category of ELE because they often participate in multiple ELEs while at Furman.

Another way to capture the effect of the number of ELEs (specifically research, internship, and study away) on postgraduation outcomes was to conduct a binary logistic regression, using continuing education and full-time employment as the outcomes (0 for employment, 1 for continuing education) and three different ELE types (research, study away, and internship) as predictors. As shown in Table 8, of the three ELE types included, only research was a significant positive predictor of continuing education, such that as the number of research experiences increases, so too does the likelihood of continuing on to graduate or professional school.

Table 8. Predicting postgraduation outcomes from the sum of ELEs

Postgraduate outcome	Engaged learning experience			
	Research	Study away	Internship	Constant
	B(*SE*)			
Continuing education	.325(.066)***	-.059 (.079)	-.002 (.079)	-.125 (.108)
Employment (for those not continuing education)	-.109 (.082)	-.17 (.095)	.25 (.103)*	.758 (.13)***

Note : ELEs = Engaged learning experiences.
*** $p < .001$. *$p < .05$.

For those graduates who do not continue on to graduate school (or pursue another professional degree), the remaining options are (primarily) employment or nonemployment. We could then also test if UR predicts full-time employment postgraduation. To this end, we conducted a binary logistic regression, excluding all graduates who went on to graduate school, where full-time employment (coded as 1) or not employed (coded as 0) were the outcomes, and included the same three ELE types as predictors. Table 8 shows that of the three ELE types included, UR does not predict employment, but internship experiences do; that is, as the number of internships increases, so too does the likelihood of finding full-time employment).

Reflection as Assessment

As described at the outset of the paper, one way we modified our approach to UR was to emphasize to students the importance of reflecting on their UR experience before, during, and after it and providing them with some guidance on how to reflect through required professional-development sessions. Although the UR students' self-reports of how often they engaged in reflection suggest that this is an area we can improve upon, reflection is an integral part of our assessment process. We have been able to collect robust quantitative data on student's perceptions of the UR experience. The structure of our assessments fosters reflection because students articulate their expectations for the experience at the outset and then reflect at the end of the experience on if it met those expectations. Students respond to one of two prompts aimed to encourage reflection on either (1) their sense of purpose or (2) integrative learning. Both of these learning outcomes were a part of our QEP application. Thus, the reflection assignment ensures that students reflect on their experience and it provides a way to assess their experience. We are in the process of reviewing reflections, of which to date we have more than 200.

To summarize, our assessment of UR, which includes preexperience expectations and postexperience perceptions as well as reflections and postgraduate outcomes (1) mirrors the changes we made to focus ELEs on the student experience and (2) provides us an evidence-based approach to continue to refine our student-centered approach.

Conclusion

Higher education institutions face integrated yet competing challenges to demonstrate their value. Whether it is by proving student learning or career preparedness in students or continuing to find innovative ways to tell the institutional story, they are struggling, now more than ever in the wake of the COVID-19 pandemic, to illustrate their value to the public. By placing students at the center via HIP alignment at every level of collaboration (students, faculty, department units, and university programs) we were able to accomplish positive outcomes in a compressed time frame—although we still have work to do. We share this case study as an example of one way to refine rapidly (by higher education standards) an already strong program in support of student success. As we collectively embark on reimagining higher education in the post-COVID years, keeping students and HIPs at the center of the story will serve us well.

References

Behar-Horenstein, L. S., Roberts, K. W., & Dix, A. C. (2010). Mentoring undergraduate researchers: An exploratory study of students' and professors' perceptions. *Mentoring & Tutoring: Partnership in Learning*, *18*(3), 269-291.

Evans, N., Forney, D., Guido, F., Patton, L., & Renn, K. (2010). *Student development in college: Theory, research, and practice* (2nd ed.). San Francisco, CA: Jossey-Bass.

Finley, A. (2019, November). *A comprehensive approach to assessment of high-impact practices* (Occasional Paper No. 41). Urbana, IL: University of Illinois and Indiana University, National Institute for Learning Outcomes Assessment (NILOA).

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

Kilgo, C. A., Sheets, E., & Pascarella, E. T. (2015). The link between high-impact practices and student learning: Some longitudinal evidence. *The International Journal of Higher Education and Educational Planning*, *69*(4), 509–525.

Kinzie, J., & Zilvinskis, J. (2016, October). *Using NSSE results to inform campus plans to expand high-impact practices and assess impact*. Presentation at the 2016 Assessment Institute in Indianapolis, Indianapolis, IN. http://hdl.handle.net/2022/24346

Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2001). Experiential learning theory: Previous research and new directions. In R. J. Sternberg & L. Zhang (Eds.), *The educational psychology series: Perspectives on thinking, learning, and cognitive styles* (pp. 227–247). Erlbaum.

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

Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*, *347*,1261757. https://doi.org/10.1126/science.1261757

Lopatto, D. (2006). Undergraduate research as a catalyst for liberal learning. *Peer Review*, *8*(1), 22–25.

National Society for Experiential Education. (1998). *Eight principles of good practice for all experiential learning activities*. Retrieved March 23, 2020 from: http://www.nsee.org/8-principles

O'Donnell, K., Botelho, J., Brown, J., González, G. M., & Head, W. (2015). Undergraduate research and its impact on student success for underrepresented students. *New Directions for Higher Education*, (169), 27–38. https://doi.org/10.1002/he.20120

Potter, S. J., Abrams, E., Townson, L., & Williams, J. E. (2009). Mentoring undergraduate researchers: Faculty mentors perceptions of the challenges and benefits of the research relationship. *Journal of College Teaching & Learning (TLC)*, *6*(6).

Shanahan, J. O. (2017, December). *"I didn't think students like me got opportunities like this": Using the RSD framework to address equity gaps in undergraduate research*. Paper presented at the International Conference on Models of Engaged Learning and Teaching (I-MELT), Adelaide, Australia.

Southern Association of Colleges and Schools Commission on Colleges (2018). *Principles of Accreditation, Quality Enhancement Plan* (Standard 7.2). Retrieved January 5, 2021 from https://sacscoc.org/app/uploads/2019/08/2018PrinciplesOfAcreditation.pdf

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 72-83.
doi: 10.14434/josotl.v21i1.30361

Undergraduate Researchers: Mentees and Mentors

Jenni L. Redifer
Western Kentucky University
jenni.redifer@wku.edu

Derick Strode
Western Kentucky University

Cathleen Webb
Western Kentucky University

Abstract: This article describes the tiered mentoring approach to undergraduate research at a regional comprehensive university. In addition to mentorship of undergraduate student researchers by faculty and graduate students, tiered mentoring includes high school student researchers. The high-impact practice of student research is particularly impactful at this institution, where 40% of first-year students are first-generation college students, and the campus houses a residential science, technology, engineering, and mathematics high school. The wide variety of opportunities for student research involvement, including opportunities for students to serve in both mentee and mentor roles, has contributed to tiered mentorship becoming a prominent component of our university culture. Strategies for beginning and expanding the involvement of high school students as researchers in postsecondary settings are discussed.

Keywords: student research, peer mentoring, high school students, tiered mentoring

Undergraduate research is categorized as a high-impact practice because of its effect on academic performance (Bhattacharyya, Chan, & Waraczynski, 2018; Fechheimer, Webber, & Kleiber, 2011; Kuh, 2008), scientific skills, pursuit of scientific careers (Lopatto, 2010), and retention of students who are female or members of minority racial or ethnic groups (Nagda, Gregerman, Lerner, Von Hippel, & Jonides, 1998). Mentoring is a critical component of many research programs for undergraduates, and the mentoring aspect of student research appears to be particularly beneficial for science, technology, engineering, and mathematics (STEM) students who are members of underrepresented groups (MacPhee, Farro, & Canetto, 2013).

This article examines the benefits of mentored research to student researchers, their faculty mentors, and to the universities and communities where the work takes place. We discuss the benefits of undergraduates not only receiving mentorship in research, but also serving as mentors to less experienced researchers. We refer to this as a tiered-mentorship approach and examine the learning that takes place as more experienced student researchers communicate and guide their less experienced peers. We profile the tiered-mentorship approach at a regional comprehensive university, including an intensive focus on how high school students from an on-campus specialized, residential high school academy at the university are involved in mentored research. Although some components of our institution's method of involving high school students in research are specific to the residential academy structure, others are more widely applicable. Approaches to involving high school students in mentored research used by other universities and research organizations are also discussed. Finally, we outline strategies for establishing a culture of providing research mentorship to high school students in a postsecondary environment.

Mentored Research: Increasing the Reach of a High-Impact Practice

In addition to the numerous deep-learning opportunities for high school students, mentored research can be hugely beneficial to participating faculty and undergraduate researchers. In our experience, high school students who seek out additional research opportunities are highly motivated and can often be described as "self-starters." However, barriers to access may discourage some high school students who would otherwise be inclined to seek out research opportunities at a college or university. Purposeful outreach from postsecondary institutions to secondary schools to engage high school students early is one way to begin removing barriers. One widely utilized practice is dual-credit relationships between high schools and local colleges. These programs bridge high school to university classroom learning experiences, expand high schools' curricular offerings, and ready students for the rigor of college, providing appropriately challenging offerings to interested students. Scaffolding from this common model of dual-credit collaborations, we encourage high schools and universities to examine their local communities anew to identify partnerships to engage high school students in mentored research. High schools can work to facilitate this process, as some magnet schools have done by recruiting research mentors and matching them up with students (Wheeler High School, 2020). Similarly, some universities have created pipeline programs to involve high school students in original, mentored research. Alternatively, welcoming faculty mentors may even invite local high school students into their research groups independently, finding that it is a student's curiosity, not their age or grade level, that leads to success in research (Murray, Obare, & Hageman, 2016; Roberts, Breedlove, & Strode, 2016).

By involving area high school students in mentored research projects, universities provide an outlet for higher level learning that few high schools have the resources or ability to provide. Barriers to conducting mentored research in secondary schools include limited budgets, expectations to prepare students for performance on standardized metrics, lack of access to advanced equipment and instrumentation, and little time in the face of other demands (Murray et al., 2016). For high school students, mentored research is a way to harness academic energy into meaningful contributions to real problems, and to enhance the scope of academic experiences. Those who offer student research opportunities provide a mechanism to accelerate learning in ways high schools cannot do alone. Murray et al. (2016, p. 3) called for research access for students to be "early, often, and universal," suggesting that if all students could conduct original research, early results would include a more scientifically literate population overall, more students pursuing STEM, a homegrown, innovative culture, and greater diversity in the STEM workforce.

Professional organizations can also play a role in facilitating high school student involvement in research, as well as in encouraging faculty to invite high school student researchers into their research groups. The American Chemical Society's Project SEED (Summer Experiences for the Economically Disadvantaged) provides funding for high school students to conduct research on campus with university faculty during the summer. The American Psychological Association (APA; 2020) maintains a list of research mentors by state, including those willing to mentor high school students. The APA (2016) also publishes a freely available manual for conducting psychological research for science fairs. Both APA resources provide avenues for faculty to reach out to high school students to provide mentoring, access to laboratory equipment, and other support to facilitate independent or guided research.

Other Routes to Mentored Research for High School Students

Summer research internships offer another avenue for high school student research involvement. Examples include the Research Science Institute and the Summer Science Program. Students from both programs conduct research at universities with faculty mentors, and these programs provide the opportunity to engage in full-time research for several months. The Research Science Institute is hosted by the Massachusetts Institute of Technology (MIT). Participants are placed under mentorship from faculty at MIT, other Boston area universities, and corporate and government-sponsored research labs. Summer Science Programs take place at New Mexico Tech, University of Colorado Boulder, Purdue University, and Indiana University. Additionally, the National Institutes of Health's Summer Internship Program welcomes high school and undergraduate applicants, placing students under mentorship from NIH professionals. Like traditional academic-year experiences, summer research programs give high school students the opportunity to explore research, but in a more immersive way than many undergraduate students ever experience.

Murray et al. (2016) compiled an extensive list of competitions, fairs, and internship programs specific to high school researchers, as well as a collection of journals for early-career researchers. Many discipline-specific conferences and meetings have a student poster session that is also open to high school students. In addition to programs designed specifically for high-school-aged researchers, mentors can involve younger researchers in working toward the same outcomes that undergraduates in the lab may be working toward.

Benefits of Mentored Research for Students

High school students who seek research opportunities at local universities are often hungry for challenge and seek a supportive environment to grow their own skills quickly. This drive can help them become productive, task-focused, dedicated researchers. High school students who conduct mentored research often achieve the same outcomes as their undergraduate peers, including presenting at discipline-specific meetings and conferences or coauthorship of manuscripts. In a research mentoring program for high school sophomores, notable outcomes included student-authored scientific publications and significantly higher science knowledge and scores on measures of 21st-century skills among participants, compared to a control group (Puslednik & Brennan, 2020). Faculty researchers who mentor high school students form teaching relationships with teams of students interested in similar problems and reap the reward of nurturing the next generation of motivated researchers. Likewise, students who take on research projects are motivated by faculty who take an interest in and encourage them to think in new and more complex ways, resulting in students who become "hooked on learning" (Atkinson, Hugo, Lundgren, Shapiro, & Thomas, 2007) and who work harder as a result.

Another advantage of bringing younger students into a research group is the ability to create a tiered, team mentorship model. The tiered approach holds advantages for everyone involved. In fields where the benefits of mentorship are well established, a tiered approach can increase the likelihood that students receive mentoring (Kman, Bernard, Khandelwal, Nagel, & Martin, 2013). By empowering more experienced student researchers to train, teach, or co-mentor newer team members to operate equipment, follow research protocols, and analyze data, faculty time can be redirected toward activities that benefit the entire research group but are not as easily delegated (e.g., planning future research projects). At the same time, the benefits of learning through teaching trickle down to other members, who may later become research mentors themselves. Serving as a peer mentor in a college setting provides numerous advantages, both academically and socially, for the mentor (Kiyama & Luca, 2014). Tiered mentorship leads to research groups comprising students with varying levels of expertise and evolving degrees of leadership. Thus, students experience rich teamwork situations that go far beyond the typical class project. Results from the Summer Undergraduate Research Experience survey indicate that the more experienced members of groups who provide peer mentorship to newer members enjoy the teaching role and see self-benefits, including a growth in self-confidence, increase in their own motivation, and improved communication skills (Lopatto, 2010).

For the student researcher, benefits are both professional and personal (Lopatto, 2010). Mentored research is a means to explore career options. As students enter college and declare majors, they may narrow their choices to options with which they are already somewhat familiar. Taking classes within the major helps students understand if the choice is a good fit for them individually. However, this is a slow, trial-and-error process leading to many students changing majors as they learn more about their own fit within a discipline and resultant career options. Involvement in research accelerates this self-exploration, helping students quickly understand how a professional within that discipline approaches and solves problems. Participating in research is also a confirming and clarifying experience, with many students "fine tuning" their career plan as a result of what they learned about themselves during their experience (Lopatto, 2010). High school student involvement in mentored research can serve as an even earlier strategy to help students find clarity when choosing a major and assessing career options (Roberts, 2013). Early involvement in research provides an early confidence boost, strengthens teamwork skills for the young participant (Bhattacharyya et al., 2018), and results in a deeper understanding of science (Murray et al., 2016). As Atkinson et al. (2007) noted, when highly motivated students interact with peers and teachers who care about the same problems as they do, they find new motivation and self-validation, some realizing for the first time that it is good to be smart.

For high school students, mentored research can lead to a plethora of opportunities for additional experience and recognition. The Regeneron Science Talent Search is the oldest and most prestigious high school research competition, accepting research reports from high school researchers around the nation. Prizes are awarded, including the $250,000 top prize. The Regeneron International Science and Engineering Fair brings together 1,800 top students from around the world each year to discuss or demonstrate their work, resulting in $5 million in scholarship awards. Other competitions are open to students in disciplines outside of STEM, such as the Davidson Fellowship, which targets students 18 and under who have completed a major body of original work. A substantial number of the students who have reached these impressive stages conducted their work at a local university with mentorship from university faculty.

Benefits of Peer Mentoring for Mentors and Faculty Supervisors

Interaction with peers during the research process is common among undergraduate researchers and is viewed favorably by both mentors and mentees (Hayes, 2018; Lopatto, 2010). Student researchers who have served as mentors to other students have described their experience as a boon to their communication skills and motivation to conduct research (Lopatto, 2010). The interactive process of peer mentoring illustrates the benefits of learning as a social activity and exemplifies the idea of teaching as learning (Lave, 1996). Serving as a mentor also enriches the student researcher's grasp of the content: The process of explaining material to someone else and answering questions about the material, as in the case of peer tutoring, strengthens tutors' understanding (Evans & Cuffe, 2009) and encourages them to investigate the answers to questions they are unable to answer (Galbraith & Winterbottom, 2011). These benefits increase when the to-be-learned material is more complex (Duran, 2017), a likely scenario for research mentoring. Serving as a peer mentor can "professionalize" the research experience for undergraduate researchers, giving them an additional sense of responsibility above and beyond their regular lab duties. Undergraduate research mentors may feel a sense of ownership of the area in which they are mentoring other students, which can increase their engagement (National Survey of Student Engagement, 2005), sense of purpose, and research self-efficacy (Berkes & Hogrebe, 2007).

Faculty who encourage peer mentoring in their research groups may also benefit from this process: When student researchers are allowed to take on leadership roles, they can then model the mentoring process for mentees who may eventually serve as mentors themselves. Using a mentorship structure can increase faculty members' research productivity and output (Morrison-Beedy, Aronowitz, Dyne, & Mkandawire, 2001). For faculty who invite high school student researchers into their research groups, potential benefits include working with highly motivated individuals, resultant lab group productivity, more robust progress on initiatives, and increased scholarly output including presentations, publications, and external funding efforts, as well as the opportunity to mentor motivated individuals who challenge the mentors themselves. Students who are ready to serve as mentors are typically also ready to contribute more to the research process and may feel greater responsibility for project outcomes than students who see their roles as less responsible. In a practical sense, allowing trustworthy student mentors to serve as leaders may help a faculty member's research group or laboratory function more efficiently, without constant oversight of every task from the faculty member. For example, Texas A&M University's LAUNCH (learning communities, academic excellence, undergraduate research, national fellowships, capstones, and honors) program provides broad access to research opportunities across many different disciplines. More experienced student researchers serve as team leaders who not only direct projects but also review applicants and select new student researchers to join the team. Thus, a tiered-mentoring approach is built into the LAUNCH model, owing to its incorporation of student-led projects, potentially reducing the workload of faculty who serve the initiative. The student-led structure may also help research seem more welcoming to students who are intimidated by the prospect of contacting an unknown faculty member directly, thereby increasing the size of faculty members' applicant pools.

Benefits to Universities and Local Communities

Universities and local communities benefit from involving high school students in the research process. Precollege research experience can serve as a recruiting mechanism for universities. Early involvement with a research mentor and team of "near peers" can be a deeply rewarding learning experience, helping a high school student imagine the next 4 years at the same institution. Mentored research of high school students can provide long-term benefits to both the student and faculty member if the student elects to complete their postsecondary studies at the same school.

Involving students from the local community in research offers a path to cultural and community insight that faculty often lack, given that many faculty relocate to accept academic positions. Even the undergraduate population does not comprise "locals" in the same sense as high schools. Adding high school students to a research team could be of particular benefit to explorations of community problems that require an understanding of cultural significance, group dynamics, or information that is not well known outside the local community.

Tiered Mentoring: An Approach to Involving High School Students in Research

Tiered mentoring is utilized in a variety of fields for numerous purposes, including improving retention of community college students (Jaswal & Jaswal, 2008) and increasing professional development more broadly (Yale University, 2020). Tiered mentoring is an effective approach to introducing students to scientific research (Hayes, 2018). Traditionally, tiered mentoring occurs when a faculty supervisor mentors a graduate student who in turn serves as a mentor to an undergraduate student. For example, in a large psychology research group, faculty might mentor several graduate students who are each responsible for a subgroup working on a portion of the faculty member's larger project. Subgroups could consist of advanced and less-experienced undergraduates who work together to complete tasks such as literature reviews, investigating data collection techniques, and pilot testing study materials. The graduate students would supervise these activities, seeking input from the faculty mentor as needed. Meanwhile, the graduate students would receive mentoring from the faculty mentor. In a biology lab, advanced undergraduates might train less-experienced undergraduates on field data collection protocols, while graduate students train the advanced undergraduates on data analysis techniques and the faculty supervisor mentors graduate students through the manuscript writing and submission process, in addition to providing feedback and guidance on the mentoring provided by the graduate students. Regardless of the discipline, tiered mentoring often involves a faculty member providing "big picture" guidance, with a graduate student responsible for day-to-day supervision of undergraduates, and advanced undergraduates serving as trainers in basic techniques to less advanced undergraduates.

At our regional comprehensive university, undergraduate research is an essential component of faculty scholarship. Approximately 40% of our first-year students are first-generation college students. Undergraduates are encouraged to join research groups early in their academic careers so that they can learn the skills to design their own studies. By encouraging early student involvement in research through a variety of structures such as course credit for mentored research, combined bachelor's/master's degree programs that have expanded to more than 20 programs in our institution over the past decade, an annual student research conference, and internal undergraduate research grants, we maximize opportunities for advanced scholarship for a broad range of students. As a result, students may start conducting research as first-year students and continue through their senior year, giving them more experience than newer graduate students in the same lab, in some cases. This structure prepares our undergraduate researchers for a wide variety of research roles, including serving as principal investigators of student-led research projects and as mentors to other student researchers. Similar structures can be found across the United States at many types of colleges and universities, ranging from small liberal arts colleges to large research-intensive public universities.

Tiered mentoring can also be applied in research settings that include high school student researchers. High school students may begin their research careers by shadowing undergraduate researchers and enrolling in a lower division independent research course. After receiving training from more advanced student researchers, high school students may move on to collecting data and assisting with research design. Less advanced students need more mentoring. Consequently, the structure of our tiered mentoring approach builds in frequent interaction between new lab members and more experienced researchers. The "tiers" do not insulate faculty members from undergraduates but rather provide the opportunity for mentoring at multiple levels. When high school students join research labs, they receive an even more individualized mentoring experience, benefitting from the guidance of newer undergraduates, advanced undergraduates, graduate students, and faculty.

Strategies to Provide High School Students with Research Mentorship

Universities or faculty mentors serious about involving high school students in opportunities to conduct mentored research have many models to consider. Options range from individual faculty members allowing high school students to join their research groups to institution-wide partnerships organized with local school districts. Universities with ambitious goals to include high school students might consider partial-day programs arranged with local school districts or target high schools. As in a dual-credit arrangement, upper level high school students could leave the high school for part of the school day to engage in mentored research projects with university faculty. Such an arrangement could result in credit for a university course. Parental and school district support for these programs may increase if they view research participation as a pipeline to expected outcomes such as conference presentations, entry to STEM competitions, or facilitation of an application to a prestigious summer research program or scholarship opportunity.

Specialized high schools often have instructional periods dedicated to student engagement in activities such as mentored research. One example is the Illinois Mathematics and Science Academy. Through its Student Inquiry and Research program, students who opt in for research participate with various partners in the greater Chicago area each Wednesday—called Inquiry Days—including at host universities such as the University of Chicago and Northwestern University. At the Clark High School in Cincinnati—the nation's oldest Montessori school—the curricular instruction stops for 2 weeks twice per year for intersession studies while students participate in some form of experiential learning. Such creative arrangements could be reimagined for universities to outreach to local districts or target schools to invite high school students to participate in mentored research projects.

Tiered Mentorship of High School Student Members of the University Community

One unique aspect of our institution is a statewide, specialized STEM high school located on its campus. The Gatton Academy is a member institution of the National Consortium of Specialized STEM Schools (NCSSS) and fits within the federally defined realm of "specialty-STEM schools" (Every Student Succeeds Act, 2015). There are two types of specialty-STEM schools: self-contained high schools that offer advanced and honors STEM courses, Advanced Placement courses, and dual-credit courses, and high schools that serve as early-college academies, where the curriculum is completely integrated with a university, and students learn from university professors alongside traditional university students (Almarode, Subotnik, & Lee, 2016; Jones, 2009; Roberts, 2013). The Gatton Academy is an early-college academy, located on the campus of Western Kentucky University and operating as a university academic department. Among the approximately 100 member schools of the NCSSS, almost all have student research programs (Atkinson et al., 2007; Jones, 2009). Schools such as these have been identified as models that provide students with the background to become problem solvers; there are calls to create additional institutions to meet the U.S. demand for qualified STEM professionals (Atkinson et al., 2007; Committee on Prospering in the Global Economy of the 21st Century, 2007).

The Gatton Academy is one of 15 state-supported, residential STEM academies currently in existence, with another slated to open in 2020. High-performing students from across the state who have a demonstrated career interest in STEM are invited to apply for the 2-year program during their high school sophomore year. Through a competitive and holistic admissions process, approximately 100 students are accepted each year, keeping the Gatton Academy's total enrollment near 200 students. During the 2-year program, students complete the requirements for their junior and senior years of high school while integrating academically into early-college life, taking a rigorous college-level STEM curriculum. The students live on campus in a specially designated residence hall, attending classes with undergraduates. Every admitted student receives tuition, housing, and meals. The Gatton Academy seeks to represent the full diversity of Kentucky, recruiting in every county of the state. Half of the students selected each year are female. Because a full scholarship is provided to every admitted student, the program is successful in including students from a variety of socioeconomic backgrounds.

Students at the Gatton Academy are encouraged to seek out opportunities to work with faculty conducting research in a variety of disciplines and to do so early, as soon as they are acclimated to their new learning environment. Original, mentored research is one of the major focus areas of the program. Facilitating student research opportunities with university faculty mentors starts as soon as new students arrive, via a research fair where faculty meet students and share opportunities for students to get involved within their labs and research groups (Roberts, 2013). Students also receive one-on-one advising help from other students to assess their interests, consider their options, and learn what will be expected in the process. Although participating in mentored research is optional, approximately 85% of students pursue this opportunity (695 of the 823 graduates to date). It is a foundational cultural value of the Gatton Academy to keep research optional so that a student's own curiosity guides the process. Although the Gatton Academy supports students throughout the research process, from finding a mentor to conducting original work to producing outcomes, engagement at every stage is student initiated (Roberts et al., 2016).

The Gatton Academy's key partnership is with faculty of Western Kentucky University, where the program is housed. The students are mentored directly by university faculty but frequently receive additional coaching, guidance, and training through the university's tiered mentoring approach from student mentors who are often more experienced undergraduates or older Gatton Academy students within the research group. For example, one of the authors had a multi-year sustained linkage of Gatton Academy research students, consisting of Gatton seniors recruiting juniors they deemed a good fit with the research group and project. Mentored projects can take place in any department or college at the university where a student receives mentorship but most often are in the natural and social sciences. Research involving collaboration between undergraduates and high school students is diverse and occurs in many academic departments. Recent examples included Gatton Academy students teaming up with advanced undergraduate researchers on behavioral science studies of substance abuse and family history (Wilgruber, Blevins, & Teeters, 2020) and the impact of trait anxiety on study strategy choices (King, Redifer, & Young, 2019). Mentoring roles in these projects were shared by faculty members and advanced undergraduate researchers. In materials chemistry, a Gatton Academy student learned from both her mentor and advanced undergraduates, using nanomaterials to develop new polymers for future technologies (Nguyen & Hill, 2020). By the student's second year, the more advanced undergraduate students had graduated and she entered the peer mentoring role, as less-experienced students joined the group. Recently, Gatton Academy students with strong computational and coding abilities were invited to join a team of engineering undergraduates. The engineering undergraduates designed a working apparatus to examine fairness of worldwide dice games, and Gatton Academy students were brought on to become the computer scientists on the team, creating a neural network to read dice rolls and a database to record and analyze results (Campbell & Dolan, 2019).

At any given time, a faculty member's research group may consist of graduate students, advanced undergraduate students, new undergraduate students, and high school students. This structure allows undergraduates to experience the value of serving as a mentor to high school juniors and seniors. The opportunity to co-mentor (alongside faculty) gives undergraduate researchers practice providing feedback and experience exercising leadership skills, which increases their research self-efficacy. Faculty, then, serve not only as research mentors but also as "mentoring mentors." Tiered mentoring provides undergraduates with insight into all aspects of the research process and better prepares them for careers requiring supervision of others. Since the Gatton Academy's inception in 2008, students have authored over 1,100 research presentations, with an average of over 100 presentations per year in the past decade. Among those graduating from the Gatton Academy from 2008 to 2014, 70% went on to major in STEM disciplines.

At the institutional level, both student participation in research and the mentoring of students have been metrics in our university's recent strategic plans. The previous strategic plan sought to increase the number of student presentations at our university's annual research conference. The conference has been held since 1970 and has expanded from a strictly science-based conference to include all forms of original student research and creative activity. It is open to graduate students, undergraduate students, and Gatton Academy students. The previous strategic plan called for an increase in presentations at the conference by 50%, from 215 total student presentations in 2011 to 325 student presentations in 2018 (Western Kentucky University, 2012). That goal was surpassed in

2014 as the culture of student research and faculty mentorship took greater hold at the university. Our university's current strategic plan calls for mentorship of students to be considered in faculty hiring, annual review, the tenure and promotion process, merit pay allocations, and faculty workload decisions (Western Kentucky University, 2018), sustaining a shift to a faculty more involved in scholarly activity. The location of the Gatton Academy on our campus and the university's strategic emphasis on student research have contributed to our culture of involving students at all levels in all aspects of the research process. This structure makes a tiered-mentoring approach ideal on our campus, but many of the strategies employed at our regional comprehensive university are applicable in other postsecondary settings.

Supporting Mentored Summer Research in University Settings

Federal agencies and professional organizations offer funding to build mentorship programs and programs that involve high school students in faculty research. For example, the National Science Foundation (NSF) Research in Undergraduate Institutions (RUI) award has funded travel expenses for high school, undergraduate, and graduate students conducting field research as part of faculty research initiatives. A recent RUI award at our institution included Kentucky high school students and high school students from Barrow, Alaska, which facilitated cultural exchange in addition to multitiered mentorship. Another example is our university's Project SEED grant, awarded to a chemistry faculty member by the American Chemical Society. This large-scale program has provided thousands of summer chemistry research internships to high school students from economically disadvantaged backgrounds. Students spend 8 to 10 weeks under the mentorship of a faculty member, working on independent research projects. At the University of Kentucky, the National Institutes of Health awarded a grant to the Markey Cancer Center to study cancer among populations from Appalachian areas. One dimension of the program is an on-campus, residential summer program for high-school-aged Appalachian students to participate in mentored research with faculty who study oncology. At our institution, increased undergraduate research has resulted in faculty mentors receiving five NSF Research Experience for Undergraduate awards. Moreover, faculty mentors have actively sought external funding for undergraduate researchers. From 2014 to 2019, the Kentucky NSF Established Program to Stimulate Competitive Research (EPSCOR) provided seed funding each year for underrepresented undergraduate researchers in Kentucky to work with faculty mentors. Faculty mentors at all Kentucky private and public institutions were eligible to apply. Western Kentucky University faculty members received 28 of 37 EPSCOR Research Scholar Program awards for a total of $327,000. Along with its beneficial impact on student experiences, tiered mentoring has increased faculty and institutional research outcomes.

In addition to summer programs that fall under the umbrella of federal initiatives, other institutions have arranged independent summer programs to involve students in mentored research. For example, at Vanderbilt University, the Research Experience for High School Students is a 6-week program that involves local students in an intensive, mentored project in the sciences. Cincinnati Children's Hospital hosts the High School Senior Summer Internship Program, which provides a half-time (20 hr per week) internship to students. Interns are paired with a clinical mentor, learn about careers in medicine and clinical research, and carry out independent, mentored research projects. Kansas's Bethel College offers a 1-week science research program that includes a peer-mentoring element where a faculty member and undergraduate research mentors lead a small team of high school students through a short-term, original research project. An evaluation of the Bethel College Summer Science Institute indicated that even a week-long research immersive experience motivated high school students to consider further STEM study (Krehbiel & Piper, 2017). The High School Summer Research Program at the University of California, Los Angeles is an example of a collaboration between a high school and a university. They developed a strategic partnership to host a residential, 8-week mentored research program for rising high school seniors. The program aims to involve high school students in original, mentored projects, develop students' science communication abilities, nurture their social growth, and help students identify options and pathways for their futures (Kittur, Shaw, & Herrera, 2017). Thus, many pathways to tiered research mentorship involving high school students are possible, ranging from individual faculty recruitment at local high schools to federally funded structured programs.

Conclusions

The tiered-mentoring approach described here facilitates the involvement of high school students in postsecondary research. Additionally, it provides more advanced student researchers with the opportunity to gain leadership experience, by serving as peer mentors to high school student researchers. Tiered mentoring serves practical purposes by allowing faculty to delegate some managerial tasks to advanced students, facilitating efficiency and lab productivity. Many faculty researchers already assign leadership roles to advanced student researchers; establishing a more formal tiered approach can expand research opportunities to those outside the university community. High school students can make valuable contributions to university research groups. Undergraduate, graduate, and faculty researchers can, in turn, play an important role in the growth and aspirations of high school student researchers.

References

Almarode, J, Subotnik, R. F., & Lee, G. M. (2016). Specialized STEM high schools. *Gifted Child Today*, *39*(4), 181–182. https://doi.org/10.1177/1076217516662099

American Psychological Association. (2016). *Conducting psychological research for science fairs: A teacher's guide and resource manual*. https://www.apa.org/education/k12/science-fair-manual.pdf

American Psychological Association. (2020). *Research mentors*. https://www.apa.org/ed/precollege/topss/research-mentor

Atkinson, R. D., Hugo, J., Lundgren, D., Shapiro, M. J., & Thomas, J. (2007). *Addressing the STEM challenge by expanding specialty math and science high schools*. The Information Technology and Innovation Foundation. https://itif.org/publications/2007/03/20/addressing-stem-challenge-expanding-specialty-math-and-science-high-schools

Berkes, E., & Hogrebe, M. (2007, April). *Undergraduate laboratory research, persistence in science, and the effect of self-efficacy beliefs: A quantitative study*. Paper presented at the American Educational Research Association, Chicago, IL.

Bhattacharyya, P., Chan, C. W. M., & Waraczynski, M. (2018). How novice researchers see themselves grow. *International Journal for the Scholarship of Teaching and Learning, 12*(2), 1–7. https://doi.org/10.20429/ijsotl.2018.120203

Campbell, C.W., & Dolan, W.P. (2019, March). *Dice mythbusters*. Paper presented at the Annual Student Research Conference at Western Kentucky University, Bowling Green, KY. https://digitalcommons.wku.edu/sel_pres/48

Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology; National Academy of Sciences; National Academy of Engineering; & Institute of Medicine. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: The National Academic Press.

Duran, D. (2017). Learning-by-teaching. Evidence and implications as a pedagogical mechanism. *Innovations in Education and Teaching International, 54*(5), 476–484. https://doi.org/10.1080/14703297.2016.1156011

Evans, D. J. R., & Cuffe, T. (2009). Near-peer teaching in anatomy: An approach for deeper learning. *Anatomical Sciences Education, 2*(5), 227–233. https://doi.org/10.1002/ase.110 Every Student Succeeds Act, 114 U.S.C. S. 1177, §§4102–4107 (2015).

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How well do undergraduate research programs promote engagement and success of students? *Life Sciences Education, 10*, 156–163. https://doi.org/10.1187/cbe.10-10-0130

Galbraith, J., & Winterbottom, M. (2011). Peer-tutoring: What's in it for the tutor? *Educational Studies, 37*(3), 321–332. https://doi.org/10.1080/03055698.2010.506330

Gatton Academy. (2018). *Climbing to greater heights*. Retrieved from https://www.wku.edu/strategicplan/documents/climbingtogreaterheights.pdf

Hayes, S. M. (2018). Engaging early-career students in research using a tiered mentoring model. In B. L. Gourley & R. M. Jones (Eds.), *Best practices for supporting and expanding undergraduate research in chemistry* (ACS Symposium Series, Vol. 1275, pp. 273–289). American Chemical Society. https://doi.org/10.1021/bk-2018-1275.ch016

Jaswal, F., & Jaswal, T. M. (2008). Tiered mentoring to leverage student body expertise. *New Directions for Community Colleges, 2008*(144), 55–61.

Jones, B. M. (2009). Profiles of state-supported residential math and science schools. *Journal of Advanced Academics, 20*(3), 472–501. https://doi.org/10.1177/1932202X0902000305

King, H.M., Redifer, J.L., & Young, R. (2019, May). *Trait anxiety and procrastination predict surface study strategy use.* Poster presented at the 31st Annual Convention of the Association for Psychological Science, Washington, DC.

Kittur, H., Shaw, L., & Herrera, W. (2017). A new model for a multi-disciplinary engineering summer research program for high school seniors: Program overview, effectiveness, and outcomes. *Journal of STEM Education, 18*(4), 25–30.

Kiyama, J. M., & Luca, S. G. (2014). Structure opportunities: Exploring the social and academic benefits for peer mentors in retention programs. *Journal of College Student Retention: Research, Theory & Practice, 15*(4), 489–514. https://doi.org/10.2190/CS.15.4.b

Kman, N. E., Bernard, A. W., Khandelwal, S., Nagel, R. W., & Martin, D. R. (2013). A tiered mentorship program improves number of students with an identified mentor. *Teaching and Learning in Medicine, 25(*4), 319–325. https://doi.org/10.1080/10401334.2013.827976

Krehbiel, D., & Piper, J. K. (2017). Recruiting STEM students with brief summer research experiences: An opportunity for colleges and their alumni. *Journal of STEM Education, 18*(4), 17–24.

Kuh, G. D. (2008). *High-impact educational practices: What they are, who has access to them, and why they matter.* Association of American Colleges and Universities. https://www.aacu.org/publications-research/publications/high-impact-educational-practices-what-they-are-who-has-access-0

Lave, J. (1996). Teaching, as learning, in practice. *Mind, Culture, and Activity, 3*(3), 149–164. https://doi.org/10.1207/s15327884mca0303_2

Lopatto, D. (2010). Undergraduate research as a high-impact student experience. *Association of American Colleges and Universities, 12*(2). https://www.aacu.org/publications-research/periodicals/undergraduate-research-high-impact-student-experience

MacPhee, D., Farro, S., & Canetto, S. S. (2013). Academic self-efficacy and performance of underrepresented STEM majors: Gender, ethnic, and social class patterns. *Analyses of Social Issues and Public Policy, 13*(1), 347–369. https://doi.org/10.1111/asap.12033

Morrison-Beedy, D., Aronowitz, T., Dyne, J., & Mkandawire, L. (2001). Mentoring students and junior faculty in faculty research: A win-win scenario. *Journal of Professional Nursing, 17*(6), 291–296.

Murray, D. H., Obare, S., & Hageman, J. (2016). Early research: A strategy for inclusion and student success. In D. H. Murray, S. Obare, & J. Hageman (Eds.), *The power and promise of early research* (pp. 1-32). Washington, DC: American Chemical Society. https://doi.org/10.1021/bk-2016-1231.ch001

Nagda, B. A., Gregerman, S. R., Lerner, J. S., Von Hippel, W., & Jonides, J. (1998). Undergraduate student-faculty research partnerships affect student retention. *The Review of Higher Education*, *22*(1), 55–72. https://doi.org/10.1353/rhe.1998.0016

National Survey of Student Engagement. (2005). *Student engagement: Exploring different dimensions of student engagement*. Bloomington, IN: Indiana University Center for Postsecondary Research.

Nguyen, N., & Hill, L. (2020, March). *Synthesis of a novel degradable polymer susceptible to oxidation*. Poster presented at Posters-at-the-Capitol, Frankfort, KY.

Puslednik, L., & Brennan, P. C. (2020). An Australian-based authentic science research programme transforms the 21st century learning of rural high school students. *Australian Journal of Education*, *64*(2), 98–112. https://doi.org/10.1177/0004944120919890

Roberts, J. L. (2013). The Gatton Academy: A case study of a state residential high school with a focus on mathematics and science. *Gifted Child Today, 36*(3), 193-200. https://doi.org/10.1177/1076217513486649

Roberts, J. L., Breedlove, L., & Strode, D. (2016). Experiential learning at the Gatton Academy of Mathematics and Science in Kentucky. *Gifted Child Today, 39*(4), 228–235. https://doi.org/10.1177/1076217516662097

Western Kentucky University. (2012). *Challenging the spirit: Action plan 2012-2013 to 2017-2018*. Retrieved from https://www.wku.edu/convocation/documents/challenging_the_spirit_action_plan_12_18.pdf

Wheeler High School. (2020). The Senior Internship & Research Experience. Retrieved from https://www.wheelermagnet.com/senior_research.html

Willgruber, A., Blevins, A., & Teeters, J. B. (2020, April). *Family history of illicit drug use moderates the relations between PTSD and cannabis use disorder*. Poster presented at the Collaborative Perspectives on Addiction 8th Annual Conference (American Psychological Association Division 50). Yale University. (2020). *4-Tiered Mentoring Program*. Retrieved from https://gsas.yale.edu/diversity/current-students/4-tiered-mentoring-program

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 84-106.
doi: 10.14434/josotl.v21i1.30564

A Taxonomy for Developing Undergraduate Research Experiences as High-Impact Practices

Abbey E. Fischer
University of Wisconsin-Eau Claire - Barron County
fischeab@uwec.edu

Kathy R. Immel
University of Wisconsin Oshkosh, Fox Cities Campus

Kristi Wilkum
University of Wisconsin Oshkosh, Fond du Lac Campus

Laura Lee
University of Wisconsin Stevens Point at Marshfield

Abstract: The call to increase student participation in high-impact practices (HIPs) to improve student learning, satisfaction, and retention is being answered in a multitude of ways. Faculty and staff involved in undergraduate research see this as validation of their efforts, which it is. However, Kuh & O'Donnell's (2013) work challenges research mentors to reevaluate their efforts in order to intentionally provide an even richer and more engaging research experience. Making undergraduate research a high-impact practice requires thinking inclusively about how the research experience can be scaled across the curriculum, adjusted to increase student engagement, and adapted to student preparation and desired learning outcomes. This article presents the work of a statewide multi-disciplinary faculty team that developed a scalable taxonomy for incorporating high-impact practices into student learning experiences and to serve as a roadmap for designing and assessing undergraduate research experiences. The authors offer a layered taxonomy, with milestones of increasing engagement, that establishes what sets a HIP undergraduate research experience apart from other HIP experiences and what distinguishes good practices from high-impact teaching. Aligning undergraduate research experiences with best practices across disciplines, types of research opportunities, and student achievement level was a key goal in the taxonomy development. We present cases where the taxonomy was applied to research opportunities embedded in general education courses across disciplines and different modalities. In these vignettes, the utility of the taxonomy as a tool for assessing course design and teaching effectiveness is examined and common challenges in development, implementation, and assessment of student learning experiences are also explored.

Keywords: high-impact practices, undergraduate research, taxonomy, multi-disciplinary.

Introduction

Undergraduate research directly involves students in the knowledge creation processes of a discipline. Involvement in these processes has significant positive effects on students from all socioeconomic and racial backgrounds (Awong-Taylor et al., 2016; Brownell & Swaner, 2009; Finley, 2011; Zilvinskis, 2015). Student researchers, who may have participated in one in-class research experience or perhaps in multiple opportunities of varying modalities, indicate a higher satisfaction with their learning, a deeper level of understanding, more confidence, and a greater ability to see themselves as a member of a discipline (Crews, 2013; Linn, Palmer, Baranger, Gerard, & Stone, 2015; Lopatto, 2004). They are also more likely to be retained and persist to graduation (Craney et al., 2011; Jones, et al., 2010; McMahan, 2015).

Table 1. High-Impact Educational Practices.

First-Year Seminars and Experiences
Common Intellectual Experiences
Learning Communities
Writing- and Inquiry Intensive Courses
Collaborative Assignments and Projects
Undergraduate Research
Diversity/Study Away/Global Learning
Service Learning, Community-Based Learning
Internships and Field Experiences
Capstone Courses and Projects
ePortfolios

Reprinted from: Kuh, George, O'Donnell, Ken, and Carol Geary Schneider. 2017. "HIPs at Ten." *Change: The Magazine of Higher Learning* 49(5): 8- 16.

Kuh identified undergraduate research as a high-impact practice (HIP) in 2008 (Table 1) (Kuh, 2008; Kuh, O'Donnell, & Schneider, 2017). HIPs are experiences that increase student engagement in their learning and positively affect student retention and graduation. Other HIPs include learning communities, service learning, and study abroad. The connecting threads amongst all HIP experiences are eight quality conditions, such as frequent feedback for improvement and meaningful interactions with others, that serve to ensure high student engagement (Table 2) (Kuh et al., 2017).

Table 2. Eight Key Elements of High Impact Practices.

1. Performance expectations set at appropriately high levels
2. Significant investment of concentrated effort by students over an extended period of time
3. Interactions with faculty and peers about substantive matters
4. Experiences with diversity, wherein students are exposed to and must contend with people and circumstances that differ from those with which students are familiar
5. Frequent, timely, and constructive feedback
6. Opportunities to discover relevance of learning through real-world applications
7. Publication demonstration of competence
8. Periodic, structured opportunities to reflect and integrate learning

Reprinted from: Kuh, George, O'Donnell, Ken, and Carol Geary Schneider. 2017. "HIPs at Ten." *Change: The Magazine of Higher Learning* 49(5): 8- 16.

As interest and investment in HIPs have grown across higher education, there has been a movement across institutions to ensure that students complete two HIP experiences during their college careers (McMahan, 2015). Students ideally complete one of those HIP experiences during their first two years and a second in their final two years. This leads to three considerations regarding the timing and delivery of these experiences. First, students should be able to access high-impact practices, such as undergraduate research, in a variety of ways. Second, HIPs should be intentionally planned to span a student's academic career. Third, all disciplines and institutions of higher education, from two-year campuses to top research institutions, have crucial roles to play in the delivery of HIP experiences.

Thus, development and scaling of high-impact undergraduate research, and increasing access to it, are priorities for many colleges and universities. The taxonomy presented here is part of a multi-tiered tool intended to be used primarily by practitioners during the design of high-impact undergraduate research experiences. The full taxonomy provides elaboration on the universal quality conditions of any high-impact practice, while the tiers presented here address the working components of a research experience and design choices for the research processes. We assert that this scalable taxonomy allows practitioners to intentionally design more engaging research experiences for undergraduates.

Modes of Undergraduate Research Experiences

Undergraduate research often falls into one of four categories: independent study, course-embedded, program-embedded, or summer research experience. When considering undergraduate research, one most commonly thinks of the independent study option or tiered research-lab mentoring experiences; however, recent literature has shown an increase in the number and variety of course-embedded opportunities (Awong-Taylor et al., 2016; Bell, 2015; Zimbardi & Myatt, 2014).

Each mode of undergraduate research requires a different level of social capital expenditure by the student. Social capital is the resources, information, and opportunities gained by knowing particular people and having had certain experiences; it functions as an asset by providing power and/or authority in social situations (Joshi, Aikens, & Dolan, 2019). Differences in students' social capital can lead to uneven participation in enriching educational experiences across socioeconomic groups (Bangera & Brownell, 2014; Martin, Simmons, & Yu, 2013; Ovink & Veazey, 2011). When faculty embed research into a non-research course, little social capital is required. All students enrolled in the course can participate in the research, and thus, this method significantly broadens participation across groups. Some degree programs build research into the curriculum from introduction to research courses to capstone research experiences (Powell & Harmon, 2014; Zimbardi & Myatt, 2014). While program-embedded experiences increase access to research, the reach is somewhat limited because students used their social capital to select and persist in the degree program. In contrast, students who have significant social capital often feel comfortable seeking and/or accepting independent study opportunities. This method, while becoming more common across institutions, provides access to the smallest number of students. Summer research experiences, similar to independent study projects, often require significant social capital due to the application and sometimes interview process. However, some summer programs specifically aim to serve the underrepresented groups, and thus increase access in that manner (Cruz, 2020).

In addition to the differences in the students' social capital expenditure, each research experience asks for varying amounts of time on task. When embedded into a content course, undergraduate research is one component of the course rather than the focus. Research is at the heart of a research-focused course, for example a methods class, but again, the student's individual research project is only a portion of the course. These two types of research experiences will have widely varying expectations on students' research time. For instance, students in a content course, like biochemistry or introduction to psychology, may complete the majority of their research during the instructional hours for a part of the semester, whereas students in a research course likely work on their project both in and out of class. Students in independent study and summer research experiences are generally more focused on the research project and spend more time on task. The most significant differences between these modes would be 1) the total number of hours spent, and 2) the number of responsibilities that occur outside the experience but concurrent to it. For both measures, summer research offers the most hours and often the most focused time on the research project.

Finally, across the modes of undergraduate research, the mentoring relationships vary between an undergraduate researcher, their peers, and faculty or staff mentor. Curriculum- and program-embedded research experiences likely occur in larger settings where the mentor works with many research students at a time; thus, these settings may reduce the amount of available one-on-one time between student and mentor. There are some instances where such research opportunities may provide small group mentoring (Carpenter & Pappenfus, 2009), but this requires a significant investment of time by multiple faculty and staff. When there is less one-on-one time with the mentor, students may find benefits in the mentorship offered by peers and more advanced students. Such peer mentoring may be abundant in summer research experiences when undergraduate researchers spend significantly more time working on their research and potentially doing so with their peers. Furthermore, mentors often make use of the additional time on task in summer to form stronger connections with their undergraduate researchers. Lastly, the hallmark of an independent study project is that one-on-one collaboration and relationship-building with the mentor.

Undergraduate Research across the Disciplines

What counts as research can be a contentious topic across a university community. The authors of this paper represent a diverse set of disciplines: biology, chemistry, communication studies, and psychology. We contend that while undergraduate research looks different across the disciplines, the overarching goals and overall framework of the undergraduate research experiences are similar. As such, these similarities were used to create a taxonomy that applies across all disciplines. The vignettes at the end of this paper demonstrate the cross-disciplinary utility of this tool.

This framework was conceived from its inception as inclusive of all disciplines and research approaches. While some could look at what we present and see it as only applicable to researchers with an empirical bend, scholars know the research techniques and practices that serve them, and they can generally put their preference in the context of alternate ways of knowing, collecting, or analyzing data. We believe there is room for all scholars to benefit from a structure that engages them to think about their research practice.

Most often the work that undergraduate researchers and mentors do is shared with a larger community. The forum for sharing could be a gallery, concert hall, or undergraduate symposium, but demonstrating what was done is generally a core element to the research experience. Before a student or mentor can report out, the student is sometimes asked to look over artifacts, numbers, or samples from the collection. They are taught processes for making sense of that collection through analysis and interpretation. Researchers across disciplines collect "data" which could consist of lab samples, survey responses, historical artifacts, images, or individual sounds. Learning the process for collecting and cataloguing these items is often part of doing undergraduate research. Before a collection is gathered, nearly every discipline surveys the field of known work to contextualize the research they will undertake. An artist often wants to ensure that what they want to create is not a close copy of prior work, and a social scientist wants to know that the question they are considering has not been previously answered. Thus, across the disciplines, there are processes for checking that what is being created goes beyond what is known.

Undergraduate research initiates students into the research process. Through this experience, students increase their disciplinary knowledge, explore their disciplinary interests, and prepare for the next steps in their academic or professional careers (Ishiyama, 2002). These outcomes are common across the disciplines and are key benefits of the research experience.

Benefits of Undergraduate Research Experiences

Numerous studies indicate one of the most significant benefits of undergraduate research is the mentoring relationship that develops between the student and research advisor (Craney et al., 2011; Joshi et al., 2019; Linn et al., 2015). Through this connection, the student learns more about the discipline and has an experienced professional from whom they can seek guidance on advancing in the profession. Furthermore, the mentoring connection often provides someone on campus with whom the student can discuss non-research concerns, navigate institutional processes, and ask for input on a range of topics (Bange, 2014). This relationship has been shown to be highly influential in a student's connection to their campus, retention in their major, and persistence to graduation (Craney et al., 2011; Joshi et al., 2019).

When students work with peers within research teams, they benefit from being a member of the group (Lopatto, 2010). They gain an increased sense of belonging within the discipline and, more broadly, within education, and this often leads to their own increased investment in both (Bange, 2014; Craney et al., 2011). An increased sense of belonging typically leads to better student retention in their major and at the university (Carragher & McGaughey, 2016; Dennehy & Dasgupta, 2017). This sense of belonging may be even more beneficial for first-generation or underserved students because it may fill a gap in their social network. These students gain a network of support that can be used to bridge gaps in knowledge, inadequate resources, and identity conflicts (Jones et al., 2010; O'Keefe, 2013). Research groups that rely on more experienced students to train incoming students provide opportunities for leadership, mentorship, and increased responsibility in project management (Lopatto, 2010). Even if the team has a flat hierarchical structure, students working in groups must coordinate their communication, work together to solve problems, and negotiate social norms (Bange, 2014; Craney et al., 2011). While these benefits are not the explicit purpose of undergraduate research, these skills contribute to a student's future success.

Additionally, undergraduate researchers gain experience in technical skills (Craney et al., 2011). Generating new disciplinary knowledge requires that students use the "tools of the trade." In a laboratory setting, students learn to use specialized equipment, prepare and manipulate samples, collect and record data, and work as a respectful lab member. Social science students may learn to design, write, administer, and analyze research questionnaires. Equally they could be trained to collect data from people via interviews, observation, focus group facilitation, or ethnographic participation, and they often have an opportunity to learn more about the IRB process at their institution. Humanities and fine arts research students also practice the skills of their professions. For example, as rhetorical scholars in training, students learn to systematically create and evaluate texts and the situational exigency, gaining skills in documenting previous examples, viewing a text, placing a text in context, thinking about impact on audience, and drawing conclusions about the impact of work.

As students actively participate in research, they learn each discipline has content knowledge to be mastered, and that the content and research must be considered within the context of other disciplines and the "real world" (Nadelson et al., 2015). Disciplinary knowledge provides the student with a foundation that includes general content knowledge, theoretical frameworks, and methodology within the field of study. Working hands-on with these components of a discipline results in students gaining a deeper understanding that will allow them to develop the skills necessary within that field. An understanding of the context is also important, such as how the discipline overlaps a broader field and the nuanced relationships to other disciplines. Opportunities to apply learning within the context of a profession or in relation to the "real world" helps to bring the discipline to life for students and allows them to see how this knowledge is relevant to their day-to-day interactions. Finally, students can share their knowledge and further strengthen it by participating in conferences, presenting their work, receiving feedback from others, and interacting with professionals in the field (Bange, 2014; Linn et al., 2015).

Undergraduate research is also an opportunity for students to further develop their inquiry skills (Craney et al., 2011; Henderson, Nunez-Rodriguez, & Casari, 2011). As students work through the research process, they may develop their own original research question or may simply need to ask questions about the project to which they are assigned. Either way, students improve at identifying and articulating what is unknown and observed. Finding answers to the unknown often requires students to dive into the literature. They become better versed at scouring databases and identifying and triangulating credible and relevant sources (Henderson et al., 2011). Once they locate relevant material, students learn to interpret and apply it to their work. As the work progresses, student researchers draw conclusions based on their understanding of the field and the data they have collected. These general inquiry skills are essential not only to a single research project, but are transferrable across courses, research experiences, disciplines, and their personal lives.

As the student makes gains in technical, content, and inquiry areas, their identity as a scholar/disciplinary expert grows (Bange, 2015; Hunter, et al., 2007; Nadelson et al., 2015). Indicators of this development include increases in self-reliance, self-confidence, desire to share their work, and a sense of belonging in the disciplinary community (Nadelson et al., 2015). Students may not initially feel as though they belong to the disciplinary community; they may struggle to see themselves as a biologist, chemist, communications specialist, or psychologist. However, experience as an undergraduate researcher gives them the opportunity to "try on" the discipline, gain confidence in their abilities, and begin their journey on the path of a disciplinary expert.

High-Impact Undergraduate Research

The numerous benefits and goals of undergraduate research highlighted in this paper, and across the literature, are part of what makes undergraduate research a high-impact practice. Student immersion into a disciplinary problem with a research mentor lends itself to a highly engaging-learning experience. However, mentors do not always know how to fit the work that needs to be done on their own research to the skills and knowledge of students who want to get involved. The actual tasks assigned to a student will vary across disciplines and even students with prior research experience may not be well prepared to fit into a new project. In addition to a wide range of possible tasks is variability in the level of autonomy afforded to the student. Looking holistically, undergraduates experience inconsistency in the range of opportunities and skills gained from undergraduate research. Thus, what is missing from prior studies of undergraduate research as a HIP is a clear delineation of the components and dimensions of the research experience and what make it high impact.

In 2013, Kuh and O'Donnell identified quality conditions (Table 2) found in every HIP that promote the high engagement of students in an educational experience. Intentionally building these into the undergraduate research opportunity ensures that student researchers get an engaging HIP experience. Lee et al. have previously described operational definitions and delineated milestones for the quality conditions (2020).

Development of an undergraduate research experience as a high-impact practice includes intentional incorporation of the universal HIP quality conditions and purposeful design of the research components. One way to facilitate such design is to use a taxonomy; this encourages the research mentor to consider the goals, or outcomes, of the research and to establish learning goals for the student researchers. In addition, a taxonomy encourages the mentor to consider the student's skill level and preparation. A taxonomy promotes the systematic and planned development of the student as researcher and can be used to design, or revise, an experience that is both high impact and matched to the skills of the students and the needs and resources of the project. Additionally, with appropriately high expectations, the intentionally designed research experience can be used to stretch students beyond their comfort zones, thus, engaging them at a higher level while increasing their skill set.

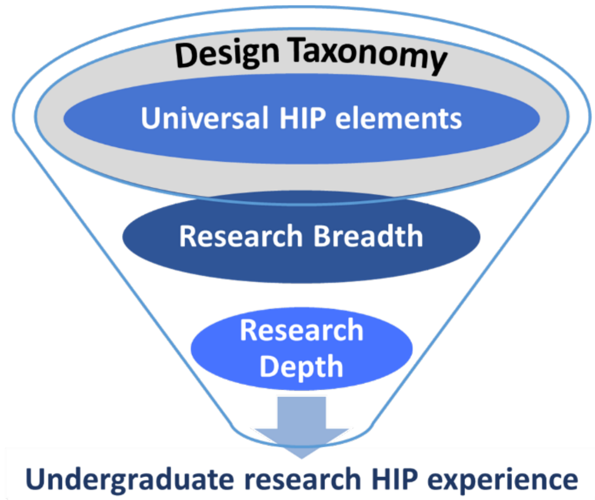

Figure 1. Overview of the taxonomy. Each oval in the funnel represents a tier of the taxonomy. Filtering an experience through the three tiers yields a HIP undergraduate research experience.

The undergraduate research taxonomy presented here is part of a three-layer system (Figure 1). By funneling the design of a learning experience through the three tiers, a research mentor can create a HIP undergraduate experience with high levels of student involvement. The first level of our taxonomy is the broadest and consists of the quality conditions, or universal HIP elements, which can be applied to any potential high-impact experience (Lee et al., 2020) Discussed below, the second and third layers of the taxonomy, research breadth and research depth elements respectively, are specific to undergraduate research and are progressively narrower in scope and focus. These layers ask the mentor to consider the level of student engagement across several criteria, including the mentor-mentee dynamic and selecting segments of the research process to focus on. To the extent that these choices in levels of engagement and involvement are intentional and consistent across the curriculum we can ensure that students are being provided with similar high-impact experiences while still allowing for autonomy and flexibility in the design and implementation of these experiences.

Table 3. Research Breadth Elements - with a focus on structure. Experience design should demonstrate all research breadth elements each at a minimum of Milestone 2.

Element	Milestone 1	Milestone 2	Milestone 3	Milestone 4
	Less beneficial UR practices	**Increasing student involvement in research**		
Originality of research	Research answer is known to student and research mentor	Research answer is unknown to student but known to mentor	Research answer to faculty-directed question is unknown to student and mentor	Research answer to student-directed question is unknown to student and mentor
Systematic disciplinary inquiry	Student inquiry into trivial, rote, and/or random avenues of research	Student inquiry into purposeful avenue of research	Systematic student inquiry into purposeful avenue of research	Systematic and significant student inquiry into purposeful avenue of research
Evaluated research process work	No segment* of research process assessed	Opportunity for one assessed segment of research process	Opportunities for 2 - 3 assessed segments	Opportunities for 4+ assessed segments
Activities emphasize research	No activities explicitly related to research	Minimal percentage of overall experience, or grade, from research activities	Meaningful percentage of overall experience, or grade, from research activities	Entire, or nearly so, overall experience, or grade, based on research activities
Required project	Either no research-related projects or such a project is optional	Short research-related project	Longer research-related project(s)	Full-term project(s)
Mentoring◊	Personnel serves primarily as instructor rather than mentor	Personnel serves as mentor to students in large groups	Personnel serves as mentor to students in small groups	Personnel serves as mentor to students on a one-to-one basis

***Research segment** = literature review, formulating question, research design, data collection, data evaluate/analysis, interpreting data / drawing conclusions, or reporting out

◊**Mentoring** = a professional relationship in which an experienced person (the mentor) assists another (the mentee) in developing specific skills and knowledge that will enhance the less-experienced person's professional and personal growth (Hanaway, 2020).

Research Breadth Taxonomy

This layer of the undergraduate research taxonomy (Table 3) contains elements that provide students with a breadth of experience in undergraduate research. It focuses on the structure of the research experience and the importance of intentionally incorporating these elements to provide students with a high-impact experience, no matter the modality. Each element is operationally defined in the form of four milestones of increasing student involvement and engagement with the research process. All six elements in the research breadth taxonomy should be present at a minimum of Milestone 2 for an undergraduate research experience to be deemed high impact; activities at Milestone 1 may qualify as low-impact involvement and would be considered less beneficial to students. The research breadth elements could be incorporated into a course syllabus or a research agreement to set clear expectations. The research breadth elements are as follows:

Originality of Research

The Council on Undergraduate Research (CUR) defines undergraduate research as "an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline" (CUR, 2021). Because the phrase "original contribution" is difficult to define, it might be most useful to focus on the state of the answer to the research question when operationally defining the milestones; who knows the answer to the research question going into the project – the student? The mentor? Both? Neither? As a research experience progresses from Milestone 1 to 4 on this element, the answer to the research question is more ambiguous, which allows student and mentor to explore concepts and ideas that are new to them. As a result, engagement of both parties should increase as they "level up" across milestones.

Systematic Disciplinary Inquiry

Systematic disciplinary inquiry seems like a daunting goal for an undergraduate research experience; however, if it is broken down into its components it is much more manageable. As the mentor structures the research experience, it is important to provide students with opportunities to seek out information and ask questions within the discipline.

Furthermore, to engage students and provide a high-impact experience, these opportunities should be structured with a plan or procedure (i.e., systematic) in place and specific goals to be achieved (i.e., purposeful). Even more engaging for students would be investigations into questions that are meaningful and significant within the discipline (Milestone 4).

Evaluated Research Process Work

The segments of the research process include literature review, formulating questions, research design, data collection, data evaluation/analysis, interpreting data/drawing conclusions, and reporting out, which are examined as depth elements of undergraduate research in the next portion of the taxonomy. In the research breadth taxonomy, this element involves embedding one or more of these segments into the undergraduate research experience and providing students with an assessment of their work. As one moves across the milestones, increasing engagement and involvement, students have opportunities to participate in additional segments of the research process. The importance of evaluation of the students' research process work is reflected in the inclusion of the word "assessed" in each of the high-impact milestones.

Activities Emphasize Research

The undergraduate research experience should be intentionally designed to include opportunities for students to actively participate in the research process and these activities should constitute a meaningful portion of the course experience and/or grade. Furthermore, these activities should be directly related to the segments of the research process described above and engage students in research within the discipline. For example, students might engage in a structured activity wherein they develop a hypothesis and then collect data on cell phone usage amongst their peers. As the milestones increase for this element, higher levels of engagement and involvement are achieved by incorporating additional research-based activities, thereby increasing the overall percentage of the experience itself or the course grade that is focused on undergraduate research.

Required Project

A research-related project provides students with a clearly defined and structured opportunity to practice, and then demonstrate their knowledge in a particular area or their prowess in executing a segment or segments of the research process. At minimum, the undergraduate research experience should include a short research-related project. Increased engagement and involvement can be gained through longer, or even full-term, research projects that fully immerse students in the research process. For example, an independent study might be built around a semester-long research-related project, while projects of varying length might be embedded within an existing course.

Mentoring

Mentoring is "a professional relationship in which an experienced person (the mentor) assists another (the mentee) in developing specific skills and knowledge that will enhance the less-experienced person's professional and personal growth" (Hanaway, 2020). Mentoring is an important component of the undergraduate research experience as it provides students with regular contact, supervision, and feedback as they engage in the research process. Overall, students report much more positive experiences and outcomes when they have had the opportunity to work closely with a mentor (Lopatto, 2010). In addition, the mentoring relationship also has potential benefits for the mentor, both personal and professional (Hunter et al., 2007; White, 2018). The milestones for mentoring in terms of mentor to mentee ratio are somewhat set by the nature of the undergraduate research experience. For example, an independent study experience would most likely have a lower ratio than a course-embedded research experience. As the milestone increases, the availability of the mentor increases and the relationship between mentor and mentee becomes more exclusive, offering further opportunities for growth and development.

Table 4. Research Depth Elements - with a focus on student learning outcomes. Experience design should include at least one element at a minimum of Milestone 2. Each milestone box could read “Students have opportunities to demonstrate….”

Element	**Milestone 1**	**Milestone 2**	**Milestone 3**	**Milestone 4**
	Less beneficial practices	**Increasing student involvement (often based on student skill level)**		
Literature review	Students collect and/or quote sources	Students collect and summarize sources	Students collect, summarize, and interpret sources	Students collect, summarize, interpret, and integrate sources
Formulating question	Students are provided the research question by the research mentor	Students select a question from a mentor-provided list	Students work in collaboration with the mentor to develop the question	Students are the primary investigators. They develop the question to be studied.
Research design	Students lack an understanding of methodology or theoretical framework OR methodology and theoretical framework are completely developed by research mentor	Students demonstrate basic understanding of elements of methodology or theoretical framework OR students play a minimal role in development of methodology or theoretical framework	Students demonstrate solid understanding of critical elements of methodology or theoretical framework OR students play a secondary (but significant) role in development of methodology or theoretical framework	Students demonstrate a thorough understanding of all elements (both critical and more subtle) of methodology or theoretical framework OR students play a primary role in development of methodology or theoretical framework
Data collection	Students collect data without understanding the context of the work	Students collect data and explain the relevance of the data to the research	Students collect data and explain both the relevance and why the data is being collected in that manner	Students collect data and explain the relevance and the why, and suggest improvements for future collection
Data evaluation / analysis	Students apply research mentor-provided methods to data evaluation	Students explain and apply the mentor-provided data analysis methods	Students find and apply their own data analysis methods	Students develop and apply their own data analysis methods

Interpretation of data / drawing conclusions	Students plug results into mentor-provided conclusions	Students draw their own conclusions based on results, but are not asked to connect the conclusions to studies beyond current work	Students draw their own conclusions based on results and relate the findings to other relevant studies	Students draw their own conclusions based on results, relate the findings to other relevant studies, and propose new work based on current study and others' work
Reporting out	Students only required to submit worksheet-like report	Students show some understanding of the subject matter and basic awareness of context, audience, and purpose in their oral or written reports	Students present information in a clear manner with fair understanding of the subject and adequate consideration of context, audience, and purpose in their oral or written reports	Students present information in a clear manner that displays their full understanding of the subject along with a thorough grasp of context, audience, and purpose in their oral or written reports

Research Depth Taxonomy

When examining research depth (Table 4), the taxonomy includes each step of the research process, from formulating questions to reporting out. Each step of the research process is one element of the taxonomy with its own set of Milestones 1-4, indicating: increased expectations for students, a "deeper" involvement in the process, and (hopefully) a more engaging experience for the students. The expected milestones built into a research experience are often based upon the skill level of the students and type of research experience. In the case of research depth, not all research experiences are created equal; some may require a student to conduct the entire research process from start to finish, while others may plug students into one or two components of the process (literature review or data collection, for example), and expect them to become extremely proficient in that small subset of skills. Yet other experiences may fall somewhere in between. As a result, the authors feel that for the research depth to be considered high impact, the design of the experience should include at least one of the research depth elements at a minimum of Milestone 2. These elements are as follows.

Literature Review

A literature review is fundamental to all research. It is necessary to determine what is already known about the subject to be studied, as well as what other researchers in the field have done. Literature review may involve finding, summarizing, interpreting, and evaluating these sources. At a minimum, students can be asked to collect sources and extract direct quotes. Unfortunately, students do not always understand what they are quoting, and often use a general "cut-and-paste" mentality. Increased student involvement with literature in the field of study is seen as students are asked to move beyond simply gathering and documenting information to summarizing or evaluating/interpreting sources. As the research design moves through the milestones, students' engagement with the literature deepens, as does their understanding of the research topic.

Formulating a Question

Asking a question is easy; asking a good, testable question may be more difficult. The key to this element is the source of the research question: does it come "pre-packaged" by the facilitator, does the student choose it from a list, or is the student truly the primary investigator, developing the question to be examined completely on their own? As the experience increases in its milestone, more of the responsibility for generating the question falls on the student, with less input from the mentor. A student who generated the question is apt to be more invested in the outcome of the research and be more engaged with the overall experience.

Research Design

Research design and methodology are extremely variable, depending on the discipline, research question, and skill of the investigators. Research may involve human subjects, documents and other artifacts, living organisms, or chemical and other non-living processes. Regardless of the specifics of the methodology, the student's role in developing the details of the project is paramount. As the student plays a more integral role in developing the methodology of the study, they should be able to demonstrate a better understanding of the process and theoretical framework of the study's subject.

Data Collection

Data collection is often a spot where students can be “plugged in” to an existing research project. It may be something mundane such as counting seeds or bacterial cultures, or something as complex as interviewing human subjects. Regardless of the discipline or subject of the study, two things are important. First, to be successful, the experience must provide the student with knowledge of discipline-specific collection procedures, equipment, and jargon. Second, context makes the work meaningful and engaging to the student; it must be evident why they are doing what they are doing and how it “fits in” to the overall research. This becomes more obvious as one increases through the milestones.

Data Analysis/Evaluation

Data analysis can often be difficult and confusing for student researchers, because it relies on potentially advanced mathematical and computing skills. However, it is vital for determining significance of data sets, and allows for explicit testing of hypotheses and determining trends and patterns in other types of data. The data analysis can be scaled to the abilities of the student researchers; careful mentoring of the research design and data collection can lead to analysis experiences that are manageable and rewarding for the student. Additionally, students can be directed toward graph and table construction as data organizational skills. In any case, as the milestones increase, more of the responsibility for finding, implementing, and developing the data analysis methods fall on the student.

Interpretation of Data/Drawing Conclusions

This is often the point where everything is tied together and research “becomes real” to the student, where they can make sense of all the numbers and observations. It is difficult for a student to do this, however, if they are simply asked to input the obtained results into conclusions provided by the mentor. As the milestones increase, the student is asked to broaden the scope of their interpretation. First, the results of the data analysis are used to accept or refute a tested hypothesis. Then, these results are put into context with what others in the field are doing. Finally, applications are made to real-world situations and other fields of study.

Reporting Out

Reporting out allows a student to share what they have accomplished with others. Indeed, public demonstrations of competence is one of Kuh’s original elements of a high-impact practice (2008). Reporting can be written, oral, or visual; individually or as a group; and, shared with an internal or external audience. Reporting out can provide students with increased confidence in their content knowledge and communication abilities, and can allow them to make contact with others for future research opportunities. As the milestones increase, students are expected to include more in their reporting: deeper content knowledge, broader context, and greater understanding of audience and purpose.

This taxonomy is designed to enable the research mentor to intentionally design, evaluate, and revise any undergraduate research experience to ensure that it is high impact for students. After confirming that the experience meets the recommendations for being a high-impact practice at an acceptable level (Lee et al., 2020), the next step is to consider the research breadth and depth elements at length. Things to consider include the desired level of engagement of each element, mode of research experience being planned, skill level of the students, and amount of resources available (time, money, etc.). The research mentor will need to decide how many of the research depth elements will be included in the research experience, and at what milestone level. These answers may be very different for a senior capstone research project than for a first-year introductory course with research components embedded in it. With all of this in mind, a high-impact undergraduate research experience can be crafted. After implementing the HIP, the taxonomy can then be used to self-evaluate the experience and make adjustments, eventually closing the loop on the assessment process.

Vignettes

The following vignettes are presented here for a two-fold purpose. First, they demonstrate the scope and variety of undergraduate research opportunities (for beginning students). As seen here, undergraduate research occurs across a variety of disciplines (science, social science, humanities), as well as across a variety of modalities (first-year content courses, independent study, replacement for "canned" lab activities, and as a component of online instruction). It also appears as different types of experiences for the student, from stand-alone experiences to embedded full-semester projects, to smaller activities during portions of the semester. Second, they demonstrate ways in which the undergraduate research taxonomy can be used in planning and preparing an undergraduate research experience for students, as well as evaluating and modifying an experience in order to "level up" the experience for the students.

Research in the General Chemistry II Lab

Abbey E. Fischer teaches general chemistry and non-majors' chemistry courses at the two-year branch campus of the University of Wisconsin-Eau Claire – Barron County. Her research and teaching pedagogy outside of high-impact practices involve the use of food to teach important chemistry concepts.

As a faculty member, I recognize the influence that my own undergraduate research experiences have had on me, and thus, I try to provide similar opportunities to students. Prior to joining the faculty at my current institution, I mentored several students in independent study projects, senior capstones, and summer research programs. All my former research students have pursued additional research opportunities, graduate studies, and/or STEM careers. This could be judged as success.

I began working with my co-authors on how to successfully implement undergraduate research as a HIP on our two-year campuses, and it led me to reflect upon my prior performance as a research mentor. What I had viewed as student independence could be viewed as lack of direction and structure, which has been shown to decrease equity (Haak, HilleRisLambers, Pitre, & Freeman, 2011; Supiano, 2018). The one-on-one conversations and group meetings were good but could be more regular and purposeful, which would strengthen the mentor-mentee relationship, increase student learning, and provide more structure. I could be more intentional in designing the experience, more deliberate in scaffolding skills, and more purposeful in promoting student engagement. And I could do all this while broadening student access to research.

The strength of the taxonomy, in my opinion, is the roadmap that it provided as I added a research project to the second semester lab of general chemistry. General Chemistry II at my campus typically has nine to fourteen students enrolled, and most plan to major in a STEM subject. We meet four hours for lecture and discussion, plus three hours for lab each week. The lecture curriculum is standard general chemistry material, but students spend most of the lab assisting with one of my research interests: developing undergraduate teaching labs that use food to teach chemistry concepts. I filtered this course-embedded experience through the layers of the taxonomy from the bottom (research depth) to the top (universal HIP elements) to create a rich, engaging research opportunity.

After two weeks of standard labs to reinforce central chemistry concepts, we switch gears to research. The campus academic librarian provides a lesson on finding relevant scholarly articles in the databases, and we discuss how to work through such articles. Students apply these skills to find articles about the benefits of undergraduate research and write a summary. This accomplishes two goals: building skills for a literature review and creating buy-in for the research experience. Using the benefits they identified, we establish two to three class goals for the research experience. Then their first intentional reflection and integration opportunity asks them to reflect upon their current mastery of those goals and how they intend to grow.

The research literature review begins with students summarizing popular press and scholarly articles that I assign. These articles provide background, context, and "real-world" connections for our work, and they serve as the basis for a discussion of the research goals. Until this point, my mentoring has been primarily to the class as a whole (Research Breadth, Mentoring Milestone 2).

Once we identify the primary research goals, students search in the literature to find methods for performing the experiments. In small research teams, they compare experimental conditions with an eye toward feasibility in the undergraduate teaching lab. Each team pitches their chosen conditions, and we reach a consensus on their next steps (Research Depth, Design Milestone 3). These small group discussions raise my mentoring to a Milestone 3, help me develop stronger connections with students, and serve as opportunities for regular and constructive feedback.

The remainder of the term is spent alternating between brief dives into the literature, pitching ideas, developing lab procedures, carrying out the agreed-upon experiments, collecting data, analyzing results, and repeating the process in light of their results. Weekly, students track their progress in their laboratory notebooks and have team check-ins with me. At least monthly, each small research team reports out to the entire class about their progress (Research Depth, Reporting Out Milestone 2), and this allows for teams to seek and provide feedback. Students take time each month to reflect on their current understanding of their work and its context, their progress toward the class skill and research goals, and how the research experience is benefitting, or could benefit, other aspects of their education and life. At the end of the term, students complete a final reflection on what they learned, skills they gained, their interest in future research opportunities, and how I could improve the experience for future students.

Students' reflections from the first two iterations of research experience suggest that they gained confidence and improved their teamwork and problem-solving skills. They also reported learning patience with themselves, their peers, and the lab work. As their research mentor, I fully concur with their self-reported gains and look forward to future offerings of this experience.

Embedding Semester-Long Research Projects into Introductory Biology Courses

Laura Lee is an associate professor in the department of Biology at the University of Wisconsin Stevens Point at Marshfield. She currently teaches courses in Botany, Zoology, Introductory Biology and Environmental Science to first- and second-year undergraduates. Long interested in course-embedded undergraduate research, she is part of a research group examining course design for high-impact undergraduate research.

One of the first labs taught in many introductory biology courses is the use of the scientific method to test hypotheses. Due to resource and time constraints, these labs are often limited to simulated experiments or short, elementary tests of simple hypotheses. I think that it is important for students to have more experience in experimental design, hypothesis testing, data collection and analysis, and scientific reporting. Therefore, I have always included short experiments into my courses, and taught simple statistics to my students to analyze their data. To create a more meaningful research experience with real-world applications, I decided to implement semester-long research projects in some of my courses. This would allow students to gain experience in experimental design and data analysis, as well as increase their engagement and make them feel more like "real scientists." In 2016, I began instructing my botany students to work in groups to conduct a semester-long project examining the validity of common "gardening hacks." In 2018, I expanded the assignment to my Introductory Biology course, broadening the scope to include any biology-related "life hack."

In both courses, students now begin with a simple "scientific method" lab during the first week of the semester. The first assignment (due in week 3) requires them to use this knowledge to explore the internet, ask a question about a gardening or life "hack," propose a testable hypothesis and prediction, and design an experiment to test it. As the semester proceeds, additional research skills are taught and practiced, and scaffolded into additional assignments: literature and citations (due in week 5), graphing or data analysis (due in week 11), and outlining the paper or talk (due in week 13). In each course, this process culminates in a "display of competence," either with a group paper written in scientific-journal style or in a group oral presentation to the class, in the style of a conference presentation. In both cases, all the component parts of the project (including the final product) sum to 100 points, equivalent to an exam. Although students are given some in-class time to work on their projects, much of the work is done outside of class, and students are given access to greenhouse and lab space as needed. Because class sizes at my institution are fairly small, I am able to meet with individuals and groups as needed.

The design of this course-embedded research did not begin fully formed in each class. The original botany project was fairly bare bones in its first incarnation, with little scaffolding and primarily summative feedback. After working with my research group to design the high-impact undergraduate research taxonomy, I realized the possibility for improving and expanding the project. In 2018, I used the undergraduate research taxonomy to self-evaluate the design of my botany course with an eye to the undergraduate research component. I put the course through all three levels of the taxonomy's funnel (universal HIP elements, research breadth and research depth), in order to evaluate my course design. For each element of each level of the taxonomy, I identified my course's current milestone, and provided a rationale for each milestone score. I then reflected on my satisfaction with each of these milestone scores, as well as any constraints implicit in the experience (student skill level, time constraints, etc.). Given these constraints, I considered how I could "level up" some of the milestones and thus, student engagement in the experience. I made changes to the botany course in response to student feedback and this taxonomy activity, including more deliberate scaffolding and clarification of the citation/literature search component via a visit from the campus librarian. I also attempted to alleviate a common problem that students have with hypotheses and predictions by giving formative feedback on this component; students were required to restate their hypotheses and predictions on each assignment, hopefully revising them in response to previous feedback.

When I expanded the semester research project into my Introductory Biology course, I was better prepared and used my prior experiences to craft a better design from the start. I incorporated the scaffolded assignments and feedback into the first iteration, but later made some changes as well. Because these students were often non-majors and did not have sufficient math backgrounds, I did not attempt to teach them statistics, but concentrated on a graphing component instead. This ~~also~~ allowed them to be more successful in their final project, a group oral presentation rather than a scientific paper write-up, and by practicing the broader skill of public speaking and the more specific skills associated with scientific presentations. In both courses, students celebrated successes and struggled with failures, but emerged with closer relationships with their peer groups and a better understanding and appreciation of the way in which science works.

Enriching a Content Course in Psychology through Undergraduate Research

Kathy R. Immel is an associate professor of Psychology at University of Wisconsin Oshkosh, Fox Cities Campus. She teaches general psychology, psychology of abnormal behavior, and developmental psychology. Her interest in undergraduate research prompted her to join a working group for her institution's reimagined associate degree that was focused on undergraduate research as a high-impact practice. This multi-disciplinary team of faculty members created a three-layer taxonomy to be used in designing and assessing high-impact undergraduate research experiences.

How has the taxonomy impacted my approach to undergraduate research in the psychology courses that I teach? Before I had the taxonomy as a guide, my approach to integrating undergraduate research in my general psychology course was rather haphazard. I would try different things each semester, adding new assignments and activities, but never measuring student learning outcomes or looking at the impact on engagement in my students.

When I joined our faculty working group, I made a commitment to undergraduate research. With the taxonomy in hand, I took an intentional approach to incorporating this high-impact practice in my general psychology course. For me, the specific steps involved in this deliberate process are planning, implementation, review, and revision, and our taxonomy is at the center of each step in the process.

As I **plan** the course, I look at each layer of the taxonomy. First, I carefully consider which milestones I want my students to achieve for each of the elements of high-impact practices. The first time I taught the course with embedded undergraduate research, most of these elements (e.g., performance expectations, investments of time, and diversity) were at Milestone 2, just reaching the level of high-impact practices. Over time, I have "leveled up" within some of the elements. For example, increasing student engagement in areas, such as opportunities to reflect and integrate learning, and real-world applications. The second layer of the taxonomy, which details the breadth elements of undergraduate research, focuses my attention on the structure of the class itself. To incorporate these elements effectively and involve my students in the research process, I have them work in small groups (4-6 students) on a research-related project. Finally, I decide which depth elements will be the focus of our research experience. I started very tentatively with students doing a literature review, and have since added other elements to provide students with further opportunities to participate in the research process. In addition, the planning step includes a careful consideration of contextual factors, including class size, student body composition, and classroom dynamics. I also consider the resources that I have available, both course-related and personal, to devote to the class. Each of these factors has a significant effect on the choices I make regarding the level of student engagement for each layer of the taxonomy.

The second step is **implementation** and again, the taxonomy plays a central role as I track my students' progress toward the milestones I have established. I take detailed notes during the implementation phase, looking at where students are making progress (i.e., what works), grading time, and student feedback, and I adjust along the way. For example, the literature review that I assigned to individual students was a "bear" to grade, student feedback was not positive, and learning gains were negligible. Students were much more receptive to working in small groups on a research question of their own choosing, with assigned roles for reviewing the literature.

Step three is a thorough **review** of the course utilizing several data points, including student grades, feedback from course evaluations, student surveys on the research process, and careful examination of the notes that I took during the implementation phase. I look for key themes related to class climate, learning objectives, assignments, grading, and course expectations. The framework of the taxonomy is the backdrop for my review and the data points that I have collected allow me to pinpoint the milestones that I achieved. I am also able to examine any discrepancies between the milestones I identified in the planning stage and the milestones actually achieved by the end of the term.

The final step, **revision**, leads me back once more to the taxonomy as I revisit the milestones of engagement for the HIP elements, student involvement in the undergraduate research breadth elements, as well as the depth elements that I chose to include. With the student learning outcomes in mind, I carefully consider changes to the course materials, with a thorough examination of class composition and layout, activities, assessments, resources, and content coverage. Each of these factors can significantly impact the choices I make regarding the milestones of engagement for each element and the depth elements of undergraduate research I include.

With each iteration of the class, I learn new things about my students, myself, and undergraduate research. While careful planning often leads to a smooth implementation, there are some bumps along the way. When issues come up, I find it helpful to do a midterm review, seeking student feedback, and referring to the taxonomy to make the necessary adjustments to get back on track. With the taxonomy as my guide, I now take a much more intentional approach to course design and implementation to ensure a high-impact undergraduate research experience for my students.

Undergraduate Research in an On-line, Asynchronous Humanities Course

Kristi Wilkum is an associate professor in the Department of Communication Studies, University of Wisconsin Oshkosh, Fond du Lac Campus. An interpersonal communication scholar by training, she has focused research on including technology and undergraduate research into early college curricula. In this project, she is focused on incorporating undergraduate research in an online humanities course that is taken by first- and second-year students. There is no prerequisite for the course.

Incorporating undergraduate research in a humanities-based course required a reframing of the taxonomy language. There must be a tacit understanding that close reading is a methodology; data includes comparison texts form the historical record or contemporary context; analysis consists of finding patterns and omissions across texts. Undergraduate research in the humanities looks different in the method, sample, and analysis. When done well, it is rigorous, depends on evidence, and generates new insights.

A lack of rigor and quality led me to redesigning my undergraduate pop culture course to include a rhetorical research project. In a fully online format, students were charged with using rhetorical theories to understand a sample text they had selected for analysis. As beginners in rhetorical critique, the claims being made were muddled, the investigations of the text were weak, and the use of theory was nearly absent. I needed to move them toward deep use of rhetorical theory as both a technique for engaging with the text and a tool for focusing their own observations.

Applying the undergraduate research breadth taxonomy revealed areas of deficit in the course. The short papers initially taught basic rhetorical skills, but the skills, text, and theories were not explicitly linked. Each paper was an individual task. Student likely encountered the topics, theories, and assignments as if they were driven by the mode of delivery (music, movie, social media, etc.).

Applying the undergraduate research depth taxonomy called for a narrowing and focusing of skills that were being taught in this course. It was not reasonable to expect students at the freshman and sophomore level to become proficient in forming the research question, gathering data, analyzing and interpreting the results, and becoming skilled writers. Concentrating on a smaller range of skills, focused the assignments to build cumulatively upon each other. Skills that were no longer the focus were simplified and directive feedback was provided to move the student more efficiently to where they need to be. For example, the process for formulating an original research question and selecting theory were simplified and scaffolded to allow more time for students to focus on analysis. Likewise, a visual presentation of the argument and texts were used to showcase the analysis. This allowed the students to present the featured skill set.

The scaffolding of research steps enhances the students' skill in analysis and interpretation. Students learn the skills of seeing the most obvious layers of meaning and the subverted interpretations of the text. They learn to draw some conclusion about what they are seeing based on collected evidence from the text and context. Every assignment, discussion, and reading supports these two featured skills.

The course, through several iterations, has evolved to include a project that starts in the fourth week and runs through the end of the semester. Students begin early in the class identifying a text that they find interesting. In a series of subsequent assignments, they think about how to contextualize the text using similar texts, identify the questions their theory invites, and move through iterative cycles of describing and noticing elements of the text. While this is happening, the shorter papers and discussions in the course enable them to practice the skills they need for the final project. A discussion board requires the class to participate in writing research questions; another simulates the deep reading of a text as a class activity. One of the short papers focuses on placing a text in context and viewing it from multiple standpoints including the creator, intended and unintended audiences, historically, etc.

The semester project cumulates in a visual presentation of students' work to their peers through a discussion board. The final discussion in the course requires students to compare and contrast showcases of their work and challenges them to extend their analytical skills across showcases. They are charged to notice how the same theory produces similar, and novel, results when applied to different texts. This final bit of analysis solidifies their learning about their theory through conversation with other students using the same theory. They also compare their projects to those who used another theory to see similarities and differences. They finish the course with a metacognitive reflection about the final project and how it (mis)aligns with the course objectives.

Conclusion

In summary, students reap numerous benefits from participating in undergraduate research, and further benefits, including increased levels of engagement and involvement, emerge from making these high-impact experiences. We have created and presented a taxonomy that can be used for the design and implementation of high-impact undergraduate research experiences. The benefits of using the taxonomy are threefold. First, it can be used to scale high-impact experiences across the curriculum. Second, it can be used to intentionally set learning outcomes and an appropriate level for student engagement. Third, it provides flexibility in designing and adapting research experiences in response to varying degrees of student skill level and preparation. One of the challenges in developing a comprehensive taxonomy of this nature lies in designing a tool that is useful across various modalities and disciplines. The flexibility of this taxonomy, in this regard, can be heard in the vignettes where we shared our experiences, across different modes and disciplines, in designing high-impact undergraduate research offerings for our students. Although the utility of the taxonomy in other modalities (e.g., independent study, or summer research experience) and with student populations outside of our campuses has yet to be demonstrated, there is no reason to believe that it would not be as applicable in these scenarios as well.

Acknowledgements

The authors would like to thank Nate Maddux, assistant professor at University of Wisconsin - Whitewater at Rock County, for his contributions to this working group when we began our research

into how to successfully implement undergraduate research as a HIP within University of Wisconsin Colleges.

References

Awong-Taylor, J., D'Costa, A., Giles, G., Leader, T., Pursell, D., Runck, C., & Mundlie, T. (2016). Undergraduate Research for All: Addressing the Elephant in the Room. *CUR Quarterly*, *37*(1), 11–19. Retrieved from https://www.cur.org/what/publications/journals/curq/issues/

Bange, J. (2014). Undergraduate Research in the Sciences as a Series of Transformative Opportunities. *Fine Focus*, *1*, 78–87. Retrieved from https://cardinalscholar.bsu.edu/handle/123456789/201342

Bangera, G., & Brownell, S. E. (2014). Course-based undergraduate research experiences can make scientific research more inclusive. *CBE Life Sciences Education*, *13*(4), 602–606. https://doi.org/10.1187/cbe.14-06-0099

Bell, J. E. (2015). *A practical guide to course-based undergraduate research experiences*. Retrieved from http://home.sandiego.edu/~josephprovost/bmb20989-sup-0001-suppinfo01.pdf

Brownell, J. E., & Swaner, L. (2009). Outcomes of High-Impact Educational Practices: A Literature Review. *Diversity & Democracy*, *12*(2). Retrieved from https://www.aacu.org/publications-research/periodicals/outcomes-high-impact-educational-practices-literature-review

Carpenter, N. E., & Pappenfus, T. M. (2009). Teaching research: A curriculum model that works. *Journal of Chemical Education*, *86*(8), 940–945. https://doi.org/10.1021/ed086p940

Craney, C., McKay, T., Mazzeo, A., Morris, J., Prigodich, C., & De Groot, R. (2011). Cross-discipline perceptions of the undergraduate research experience. *Journal of Higher Education*, *82*(1), 92–113. https://doi.org/10.1353/jhe.2011.0000

Crews, A. (2013). A Partnership for the Future: Undergraduate Research's Mutual Benefits for Students and Administrators. *CUR Quarterly*, *33*(3), 3–6. https://doi.org/10.7748/phc2014.04.24.4.16.s15

Cruz, U. of C. S. (2020). STEM Diversity Programs. Retrieved from http://stemdiv.ucsc.edu/resources1/internshipspost-bacs/undergraduate-summer-reasearch/

CUR. (2021). Mission and Vision. Retrieved April 28, 2021, from https://www.cur.org/who/organization/mission_and_vision/

Finley, A. (2011). Assessment of High-Impact Practices: Using Findings to Drive Change in the Compass Project. *Peer Review*, *13*(2). Retrieved from https://www.aacu.org/publications-research/periodicals/assessment-high-impact-practices-using-findings-drive-change

Haak, D. C., HilleRisLambers, J., Pitre, E., & Freeman, S. (2011). Increased structure and active learning reduce the achievement gap in introductory biology. *Science*, *332*(6034), 1213–1216. https://doi.org/10.1126/science.1204820

Hanaway, M. (2020). *An Existential Approach to Leadership Challenges*. New York: Routledge.

Henderson, F., Nunez-Rodriguez, N., & Casari, W. (2011). Enhancing Research Skills and Information Literacy in Community College Science Students. *The American Biology Teacher*, *73*(5), 270–275. https://doi.org/https://doi.org/10.1525/abt.2011.73.5.5

Hunter, A.-B., Laursen, S., & Seymour, E. (2007). Becoming a Scientist: The Role of Undergraduate Research in Students' Cognitive, Personal, and Professional Development. *Science Education*, *91*(1), 36–74. https://doi.org/10.1002/sce

Ishiyama, J. (2002). Does Early Participation in Undergraduate Research Benefit Social Science and Humanities Students? *College Student Journal*, *36*(3), 380. Retrieved from https://www.researchgate.net/publication/237386612_Does_Early_Participation_in_Undergraduate_Research_Benefit_Social_Science_and_Humanities_Students

Jones, M. T., Barlow, A. E. L., & Villarejo, M. (2010). Importance of undergraduate research for minority persistence and achievement in biology. *Journal of Higher Education*, *81*(1), 82–115. https://doi.org/10.1353/jhe.0.0082

Joshi, M., Aikens, M. L., & Dolan, E. L. (2019). Direct ties to a faculty mentor related to positive outcomes for undergraduate researchers. *BioScience*, *69*(5), 1–9. https://doi.org/10.1093/biosci/biz039

Kuh, G. D. (2008). High-Impact Educational Practices. In *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., & O'Donnell, K. (2013). *Ensuring Quality & Taking High-Impact Practices to Scale*. Washington, DC: Association of American Colleges and Universities.

Kuh, G. D., O'Donnell, K., & Schneider, C. G. (2017). HIPs at Ten. *Change: The Magazine of Higher Learning*, *49*(5), 8–16. https://doi.org/10.1080/00091383.2017.1366805

Lee, L., Wilkum, K., Immel, K. R., & Fischer, A. E. (2020). A Taxonomy for Designing and Evaluating High-Impact Practice Experiences. *College Teaching*, *0*(0), 1–11. https://doi.org/10.1080/87567555.2020.1846487

Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*, *347*(6222). https://doi.org/10.1126/science.1261757

Lopatto, D. (2004). Survey of Undergraduate Research Experiences (SURE): First Findings. *Cell Biology Education*, *3*(4), 270–277. https://doi.org/10.1187/cbe.04-07-0045

Lopatto, D. (2010). Undergraduate Research as a High-Impact Student Experience. *AAC&U Peer Review*, *12*, 27–30. Retrieved from https://www.aacu.org/publications-research/periodicals/undergraduate-research-high-impact-student-experience

Martin, J. P., Simmons, D. R., & Yu, S. L. (2013). The role of social capital in the experiences of hispanic women engineering majors. *Journal of Engineering Education*, *102*(2), 227–243. https://doi.org/10.1002/jee.20010

McMahan, S. (2015). Creating A Model For High Impact Practices At A Large, Regional, Comprehensive University: A Case Study. *Contemporary Issues In Education Research – Second Quarter*, *8*(2). https://doi.org/https://doi.org/10.19030/cier.v8i2.9144

Nadelson, L. S., Warner, D., & Brown, E. (2015). Life's Lessons in the Lab : A Summer of Learning from Undergraduate Research Experiences. *Journal of STEM Education*, *16*(3), 5–12. Retrieved from https://jstem.org/jstem/index.php/JSTEM/article/view/1891

O'Keefe, P. (2013). A Sense of Belonging: Improving Student Retention. *College Student Journal*, *47*(4), 605–614. Retrieved from https://researchrepository.rmit.edu.au/esploro/outputs/journalArticle/A-sense-of-belonging-Improving-student-retention/9921862552801341

Ovink, S. M., & Veazey, B. D. (2011). More Than "Getting Us Through:" A Case Study in Cultural Capital Enrichment of Underrepresented Minority Undergraduates. *Research in Higher Education*, *52*(4), 370–394. https://doi.org/10.1007/s11162-010-9198-8

Powell, N. L., & Harmon, B. B. (2014). Two-year community: Developing scientists--a multiyear research experience at a two-year college. *Journal of College Science Teaching*, *44*(2), 11–17. Retrieved from https://my.nsta.org/resource/?id=10.2505/4/jcst14_044_02_11

Supiano, B. (2018). Traditional Teaching May Deepen Inequality. Can a Different Approach Fix It? *Chronicle of Higher Education*. Retrieved from https://www.chronicle.com/article/Traditional-Teaching-May/243339

White, A. (2018). Understanding the University and Faculty Investment in Implementing High-

Impact Educational Practices. *Journal of the Scholarship of Teaching and Learning*, *18*(2), 118–135. https://doi.org/10.14434/josotl.v18i2.23143

Zilvinskis, J. (2015). Using Authentic Assessment to Reinforce Student Learning in High-Impact Practices. *Assessment Update*, *27*(6), 7–8, 12–13. https://doi.org/10.1002/au

Zimbardi, K., & Myatt, P. (2014). Embedding undergraduate research experiences within the curriculum: a cross-disciplinary study of the key characteristics guiding implementation. *Studies in Higher Education*, *39*(2), 233–250. https://doi.org/10.1080/03075079.2011.651448

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 107-119.
doi: 10.14434/josotl.v21i1.30290

Tracking and Assessing Undergraduate Research Campus-wide: Demographics, Academic Success, and Postgraduation Plans

Kimberly Schneider
University of Central Florida
KRS@ucf.edu

Aubrey Kuperman
University of Central Florida

Andre Watts
University of Central Florida

Danae Barulich
University of Central Florida

Tyler Campbell
University of Central Florida

Abstract: *Evaluation must occur at the university level to understand the full impact of undergraduate research (UR). UR assessment is often only completed at the individual program level because of limited technology, time, and/or resources. At our large research institution, we have been documenting a wide variety of research experiences annually since the 2009–2010 academic year through an online portal. With our institutional research team and campus partners, we created interactive dashboards that display involvement in UR by semester and academic year. Here we compile data on students involved in UR compared to the university population as a whole. Consistent trends from this yearly data have shown that non-STEM (science, technology, engineering, and mathematics) students, transfer students, and part-time students are less involved in research. However, underrepresented and first-generation involvement tends to trend consistently with the university population, likely because of a wide variety of focused programming. Despite many interventions aimed at engaging students in their first three years, data show that researchers remain mostly seniors. Students are also tracked to graduation and beyond, providing a unique evaluation of UR. Grade point averages and graduation rates tend to be higher for student researchers. Time to degree is similar between researchers and nonresearchers. Students are tracked into graduate school as well and on average have an almost 50% increase in matriculation compared to nonresearchers. There are still gaps in this university-level knowledge, but this portal helps clarify campus-wide involvement and opportunities for enhancement, while serving as a comparison data set and a model system for other universities.*

Keywords: *undergraduate research, student success, high-impact educational practices, institutional research*

Background

In laboratories, research stations, and libraries, faculty and students are collaborating to create knowledge and models that advance their fields; these partnerships are the hallmark of traditional undergraduate research (UR) activity. While it can be hard to determine how many faculty and students are participating on any campus, much research has been done to discover the impact of these activities on undergraduates. There is a rich body of literature documenting the benefits of student participation in UR, including learning gains in hard and soft skills and improvement on general student success metrics.

Involvement in UR has been shown to expand students' skills across a variety of measures, including observing and collecting data, acquiring information independently, analyzing literature critically, and communicating results (e.g., Kardash, 2000; Bauer & Bennet, 2003; Junge, Quinones, Kakietek, Teodorescu, & Marsteller, 2010; Lopatto, 2007). Studies have also shown that UR students report an increased tolerance for obstacles and improved ability to work independently (Bauer & Bennett, 2003; Lopatto, 2007). Put more broadly, UR has been shown to increase students' confidence in these skill sets (e.g., Sadler, Burgin, McKinney, & Ponjuan, 2010). However, these skills and attitude changes are not the only benefits of research experiences.

UR students who participate in structured programs have also been shown to develop strong interpersonal networks with peers and mentors (i.e., faculty, graduate and other undergraduate students) that benefit them as individuals and as developing scholars. These networks help make UR program participants, particularly those from underrepresented minority groups, more likely to apply to graduate school and more competitive in the graduate school admissions process (Linn, Palmer, Baranger, Gerard, & Stone, 2015; Ovink & Veazey, 2011; Thompson, Conaway, & Dolan, 2016). Additionally, structured research programs have been shown to improve student success metrics such as retention, persistence toward graduation, and grade point averages (GPAs; NSSE, 2007; Nagda, Gregerman, Jonides, von Hippel, & Lerner, 1998; Schneider, Bickel, A., & Morrison-Shetlar, 2015; Schneider, Tripp, Nair, Straney, & Lancey, in press; Sell, Naginey, & Stanton, 2018). Several studies have shown that these effects are more pronounced among underrepresented student populations (e.g., Linn et al., 2015; Schneider et al., in press).

Less well documented in the literature is just how many undergraduates participate in UR activities nationally and at individual institutions (Blockus, 2012; Webber, Fechheimer, & Kleiber 2012; Wilson et al., 2012). Since UR is such a valuable experience, it is necessary to understand university-level participation. Getting the "count" of student participation is difficult for most institutions because of the lack of a centralized office, staff time, technical capacity, and convenient data sets (e.g., faculty annual reports, work-study employee data; Blockus, 2012; Wilson et al., 2012). These issues make it especially difficult to track involvement at large universities. There are a wide variety of approaches, but no "silver bullet" solution that works for all institutions.

One commonly used tracking tool to get a campus-wide assessment of UR activities is the National Survey on Student Engagement (NSSE), which tracks "research with faculty" as an educational high impact practice (HIP) on both the first-year and senior surveys. In 2019, national data showed that 5% of first-year students participated in research with a faculty member, while 22% of graduating seniors reported having participated (NSSE, 2019). However, this self-reported measurement is taken from a very broad statement that asks students if they "worked with a faculty member on a research project," which respondents may not interpret as requiring an original contribution to the field (Wilson et al., 2012) and may include classroom projects. Other campuses, for example, have used enrollment in UR courses to track campus-wide involvement, which is a valuable measure (e.g., Fechheimer, Webber, & Kleiber, 2011; Webber et al., 2012). Campus-specific surveys are also a common tool (e.g., Berkes, 2008). While allowing for consistency among tracked experiences, these approaches can exclude participants or count some students more than once.

In Schneider et al. (2016), we reviewed a model for overcoming one of the central challenges that many campuses face, getting a unique count, which allowed us to see the unique count of students involved in UR annually (i.e., see Blockus, 2012) and went beyond this to look at a wide variety of student involvement data in one centralized format. Many models document students multiple times annually. For example, when a student participates in a campus-wide poster symposium one spring, while enrolled in honors thesis credit that semester, most campuses might have to count the student twice. Our model allows us to count each individual student once per year, or semester, as needed. This creates clearer, more reliable demographic and enrollment trends in our data and prevents duplication.

Centralizing UR Tracking

At the University of Central Florida (UCF), obtaining an accurate count of those involved in research was a challenge. UCF is a recently designated Hispanic-Serving Institution (HSI) with a Carnegie Classification of very high research activity. This metropolitan campus has a mix of traditional first time in college (FTIC), transfer, and online-only students.

The UCF Office of Undergraduate Research (OUR) and our Institutional Knowledge Management (IKM) office began a collaboration in 2013 to collect and share information on UR activity in a database and interactive dashboard. This dashboard tracks student and faculty involvement in four broad buckets of research activity: (1) structured research programs (e.g., honors theses, McNair Scholars); (2) research professional-development opportunities (e.g., campus showcase, travel funding); (3) independent research credit completed with a faculty member; (4) paid opportunities from external research-focused grants (Schneider et. al., 2016). This approach creates a highly reliable data set but does have limitations. Those who "volunteer" as research assistants or use federal work-study funds are not counted. This is communicated to faculty and department administrators, who are encouraged to use a general "Directed Independent Research" course for students not in documented programs.

The resulting dashboard allows campus stakeholders to draw comparisons between the population of tracked UR students and the university's larger undergraduate population, which facilitates strategic program planning at the department, college, and campus levels. Between 1,500 and 1,850 students are documented through the dashboard annually. After creating the first database in 2013, OUR focused on first-generation, underrepresented, and transfer students and found that that the percentage of students involved in UR who were first generation very closely matched the percentage of first-generation students in the general student body, but that transfer students were not involved at the same rates as FTIC students (Schneider et al., 2016). However, at that time the data provided just a snapshot of several semesters. Years later, OUR continues to document student involvement demographics and additionally includes elements of student success through the dashboard.

Here we share longer term trends in our campus-wide data set. This article outlines further population-level findings, focusing on several key student demographics and student success variables. Specifically, we ask several questions about UR in a broader context:

1. What are the consistent trends in demographics of UR students compared to the campus as a whole? How can these trends support strategic planning? This includes demographics such enrollment status, transfer status, and ethnicity.
2. How do student success variables track for UR students compared to undergraduate students as a whole? Here we look at graduation rate, movement into graduate school, and a few other student success indicators that are often highly valued by institutions.

Method

Collecting data on student research involvement requires campus-wide collaboration. This includes a strong partnership between OUR and IR. Additionally, OUR partners with campus stakeholders who manage the UR programs tracked in the database. OUR and partner offices use a blend of program completion records, course enrollment, and hiring records to document student engagement.

The number of programs and opportunities tracked each year varies. In Schneider et al. (2016), 19 unique programs were documented. In the 2018–2019 academic year, however, only 14 different programs or courses were tracked. This variation is linked to internal and external funding. Inclusion criteria for this database are broad, as we seek to document all students engaged in research and scholarship creation outside of the traditional classroom when possible. Valuable partners for this project include our Honors College, the sponsored research office, STEM (Science, Technology, Engineering, and Mathematics) initiatives, and other grant-funded program offices (e.g., McNair Scholars). However, it should be noted that classroom UR experiences (CUREs) are not documented through this portal; UCF courses designated as research intensive (RI) are tracked separately through a more recent campus initiative to document a variety of HIP courses.

OUR collects data from our partners for each full year (summer, fall, and spring terms) of involvement at the beginning of the following summer term. Thus, one drawback of this model is data often lag by a year or more before they are widely available to campus administrators and staff. The process begins at the end of each spring semester, when OUR provides campus partners with a guide for cataloging data. The data set requires six inputs for each unique entry: year start, yearend, student campus ID, faculty campus ID, research term (semester), and the unique research program code. Compiled data are provided by our campus partners to OUR to organize and load to a portal provided by IKM via a custom-built process in PeopleSoft Campus Solutions (UCF's software that houses student information).

Data Validation and Processing

When all the data are uploaded, OUR and IKM partner to validate each entry through an in-depth cleaning process. IKM checks for inconsistencies, including research programs that have not entered any data for that year (i.e., missing inputs), faculty who are not associated with a college and/or department (or are not faculty, but are instead staff), and students who were not enrolled as undergraduates that semester (including recent graduates, or those enrolled in graduate classes). These inconsistencies are communicated to OUR via error validation processing reports. OUR reconciles all errors by fixing or deleting entries according to strict protocols and corrects errors in PeopleSoft (e.g., students not enrolled in a summer term who are enrolled as undergraduates the following fall are included in the data set).

Once the data are cleaned, IKM extracts the data from PeopleSoft to a data warehouse, which combines the data with housing, student enrollment, and demographic information. This process provides student enrollment information, student and faculty demographics, faculty primary department, and faculty tenure status. IKM then appends this final data set to the historical data set. This dashboard is one of several HIP dashboards provided by the university. After the UR dashboard was completed, others were added, including capstone, study abroad, internships, learning communities, and HIP-designated courses.

Dashboards

When the process is finalized, the dashboard built with SAS Visual Analytics (VA) is updated to display the new data. The VA dashboard is accessible by a select group of users on campus and contains the following six separate sections that display data from the past five academic years. Most sections can be filtered by college, department or major, program, and term. Currently, UCF has the following dashboards available to the internal community:

Student involvement. This section contains the total number of students who participated in UR (see Figure 1). It shows the unique number of students involved in the past five academic years. Many students are involved in multiple programs, but this count shows each student only once, allowing for a clear picture of total involvement. However, the data can also be sorted by program.

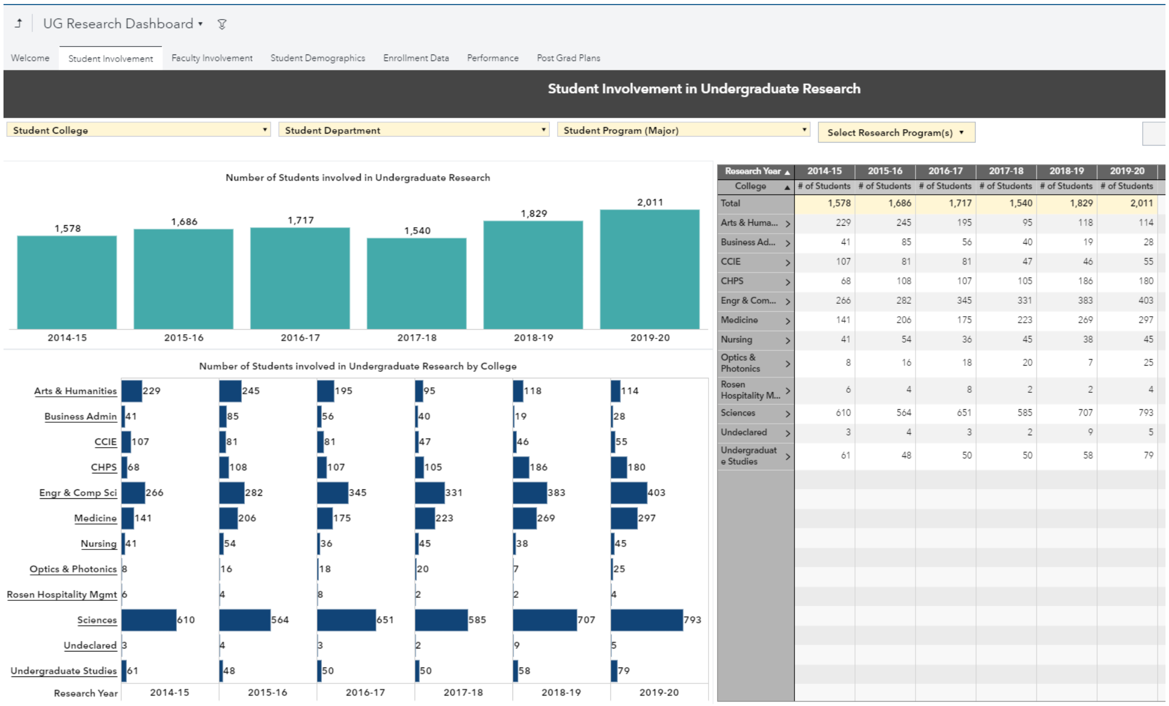

Figure 1. Example screenshot of student involvement dashboard.

Student demographics. This section includes race, gender, age, and first-generation status counts and percentages for UR students compared to all UCF students for the specified academic term (e.g., fall 2018; Figure 2).

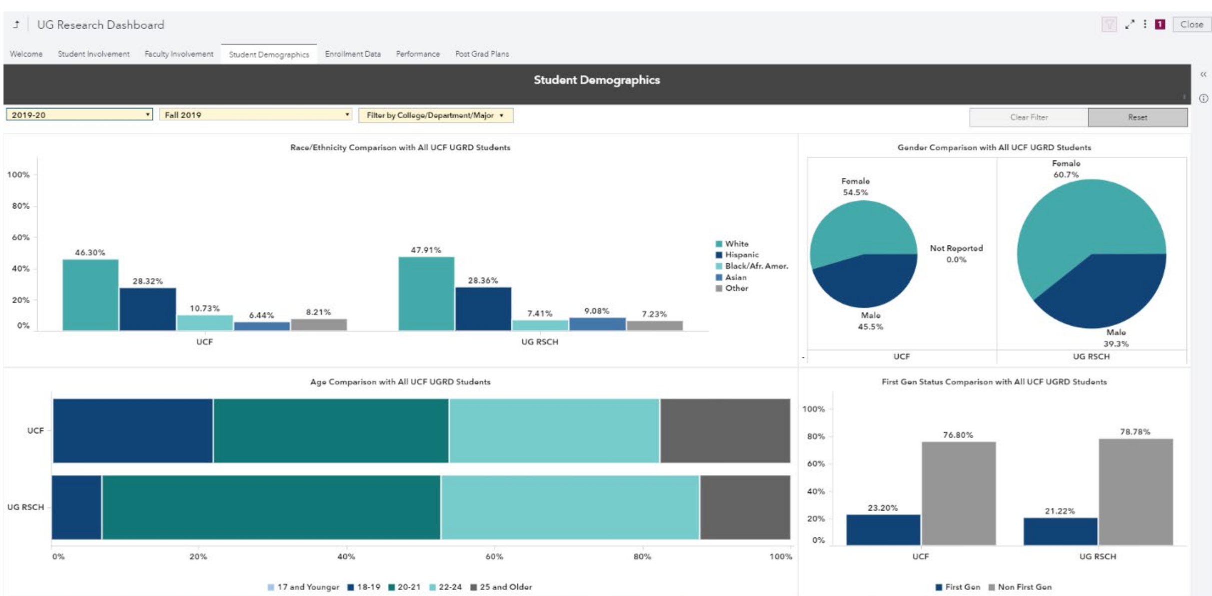

Figure 2. Example screenshot of the student demographics dashboard (fall 2019).

Enrollment data. This section includes academic level (e.g., 1st-year, senior), student type (e.g., transfer, postbaccalaureate), full-time/part-time, and college comparisons to all UCF students for the specified academic term (e.g., fall 2018).

Performance. This section contains comparisons of the average time to degree and the average GPA at graduation compared to all UCF students over the past 5 years. The tab also includes UR students' 4-, 5-, and 6-year graduation rates. Finally, the percentage of bachelor's degrees awarded to UR students is also displayed in this section.

Postgraduation plans. This section displays the percentage of students who continued their education after receiving a bachelor's degree (compared to all UCF students). Additional details include their highest postgraduate enrollment career (second degree seeking undergraduate, graduate, or doctoral program), their enrollment time (in years) in the new program after completing their UCF bachelor's degree, and the institution they enrolled at (broken out by in state, out of state, and Ivy League). Postgraduation plan data is sourced from the National Student Clearinghouse StudentTracker database. This database includes enrollment and degree information for 99% of all students in public and private U.S. colleges and universities.

Faculty involvement. Although no data from this dashboard are included here, it is relevant to mention that this section includes faculty involvement and the average number of students per faculty mentor. It also shows faculty demographic details including race, gender, tenure status, and faculty rank.

Additional Resources

In addition to the VA dashboard, OUR is also able to run more detailed reports through a specialized data and information portal to support campus operations. From this portal, OUR can pull the following: (1) faculty capacity, to look at how many faculty per department are mentoring students, (2) individual faculty mentor activity reports provided to faculty upon request, (3) detailed report of research involvement for a specific UR program or academic department, and (4) email addresses of individuals who are listed as faculty mentors in UR to be used for recruitment and communications.

Current Study

Using the above-described dashboard, we could take a close look at all student researchers. Our dashboard reports semester-level data for most cases. However, for this purpose, academic year data were examined to understand involvement over the past 5 years and beyond. Here we focus on (1) general student involvement, compiled from the student demographic and enrollment data dashboards described above, and (2) student success indicators, compiled from the performance and postgraduation plan dashboards.

Findings and Discussion

Through the UCF database we explored trends in participation, including demographics and student success indicators, and compared UR populations (i.e., students involved in UR) and the UCF undergraduate population as a whole (the university population includes UR populations).

Student Involvement

STEM. Students who were involved in UR were more likely to be in STEM majors than the undergraduate population as a whole (Table 1). For STEM we included physical and life sciences but not the social sciences. This is a consistent trend over all 5 years: On average, twice as many UR students were STEM majors compared to the UCF population as a whole (UR: 49.42% vs. UCF: 23.46%). One should note, however, that over 50% of students involved in UR at UCF are not enrolled in the traditional STEM degree programs (i.e., they are in the social sciences, humanities, arts, and business). Therefore, although UR involvement is skewed toward STEM, student research is very common beyond the STEM disciplines. Our results show a similar trend to other studies of undergraduate student participation in UR in STEM and non-STEM fields (e.g., Berkes, 2008; Fechheimer et al., 2011).

Table 1. Five-year involvement trends of several student involvement characteristics.

Characteristic	Population	2015–2016	2016–2017	2017–2018	2018–2019	2019–2020	Average
Population (*N*)	UCF	63,969	65,399	66,947	68,686	69,173	66,250
	UR	1,686	1,717	1,540	1,829	2,011	1,757
STEM major	UCF	21.3%	22.7%	23.8%	24.5%	25%	23.46%
	UR	42.0%	45.2%	54.4%	53.1%	52.4%	49.42%
Transfer [a]	UCF	44.4%	43.4%	42.0%	40.7%	40.2%	42.14%
	UR	33.6%	32.7%	25.8%	26.8%	26.2%	29.02%
Senior [b]	UCF	50.5%	50.0%	50.0%	50.1%	51.2%	50.36%
	UR	78.5%	76.4%	77.6%	79.4%	81.4%	78.66%
First generation	UCF	21.3%	21.0%	20.4%	19.6%	18.7%	20.20%
	UR	20.9%	22.1%	18.1%	17.4%	17.1%	19.12%

Note. STEM = Science, Technology, Engineering, and Mathematics; UCF = University of Central Florida and refers to the total undergraduate population; UR = undergraduate research and refers to the population of students engaged in UR.

[a] Students who transferred from our state college system with an associate of arts or sciences degree (A.A. or A.S.).

[b] This includes anyone with over 90 credit hours, and many students come in with credits and/or stay an additional year.

One interesting note in student involvement is how the data ebb and flow as a result of programs being funded by soft money, such as federal grants. For example, participation in programs funded by National Science Foundation grants tracked in the database decreased by 28% between the 2015–2016 and 2019–2020 academic years.

Transfers. Transfer students who matriculate to UCF with an associate of arts or sciences (A.A. or A.S.) degree from our statewide college system make up almost half of our student body and are less involved in UR compared to the FTIC population (Table 1). There are likely several reasons for this trend. On our campus, the transfer population typically reported working part- or full-time at much higher rates than our incoming FTIC students, in our incoming student survey (Lancey, 2020). For example, in 2019–2020, 21% of traditional FTIC students planned to work part-time and 3.1% full-time. In contrast, 30.6% and 20.6% of transfer students planned to work part-time and full-time, respectively. Additionally, transfer students have less time to learn about opportunities and often struggle with the transition from a college to university setting, further limiting their time (known as transfer shock).

Underrepresented students: First generation and minorities. For students who self-report as first generation at our institution, the percentage involved in research is typically equivalent to that of the total population (see Table 1). We see a similar trend with our Hispanic students (see Table 2) but a slightly larger gap between the percentage of Black students in the general population and the percentage engaged in UR (Table 2), which highlights an area for future focus. It is unclear what barriers may exist for this population that do not seem to be present for Hispanic or first-generation students.

UCF has many outreach programs focused on promoting UR to diverse populations, including through external funding and internal inclusive introduction to research programs. These programs reduce the barriers to research, and evidence indicates that they are producing more equitable opportunities on our campus. We see this in the parity between first-generation and Hispanic student involvement compared to the general student population. Berkes (2008) looked at ethnicity in the University of California, Berkeley UR populations, comparing STEM and non-STEM majors, rather than the student body as a whole. Her report does document that Latino/Latina students and African American students participate in UR at lower rates than other underrepresented groups.

Table 2. Five-year involvement trends by race.

Race	Population	2015–2016	2016–2017	2017–2018	2018–2019	2019–2020	Average
Underrepresented, other [a]	UCF	3.7%	4.0%	4.1%	4.1%	4.1%	4.0%
	UR	3.9%	3.9%	4.4%	4.1%	5.0%	4.3%
Hispanic	UCF	24.1%	25.4%	26.5%	27.4%	28.4%	26.4%
	UR	25.3%	25.6%	25.8%	25.6%	28.3%	26.1%
Black	UCF	11.5%	11.7%	11.5%	11.4%	10.9%	11.4%
	UR	9.3%	8.4%	7.3%	8.4%	7.5%	8.2%
Non-underrepresented [b]	UCF	60.7%	58.8%	57.8%	56.9%	56.4%	58.1%
	UR	61.5%	61.9%	62.4%	61.8%	59.2%	61.4%

Note. UCF = University of Central Florida and refers to the total undergraduate population; UR = undergraduate research and refers to the population of students engaged in UR.
[a] Native American, Pacific Islander, multiracial.
[b] White, Asian, international, not specified.

Student Success Indicators

GPA. The UR population's cumulative GPA at graduation was only slightly higher than that of the UCF undergraduate population. This varied by year, but on average was 0.2 points above the GPA of other graduating students (Table 3). This trend appears consistent with Fechheimer et al., 2011, which found that GPA was slightly higher for UR students, and that GPA increased the longer students were involved in research. We have not looked at this data regarding how many "times" students appeared in our database, but that would warrant further investigation to see if extended involvement impacted GPA (and other factors).

Graduation data: Rates and time to degree. The average years to degree completion show a very small difference between the UCF and the UR population (Table 3). However, the FTIC 4-year graduation rate, a key metric for many institutions, was consistently higher for UR students (Table 4). We only have 4 years of this data. Our first tracked cohort started in 2011–2012. UR students have not graduated in fewer semesters then the university undergraduate population. However, conducting research does not extend students' time to degree. We could not find any other articles reporting on this, but it is an important result, and it would be interesting to know if other campuses see similar trends.

We were only able to look at graduation rates for FTIC cohorts because of the complication of other groups of students matriculating in at different times. UR has been considered an effective tool to increase retention and graduation rates (e.g., Nagda et al., 1998; Locks & Gregerman, 2008; Schneider et al., in press). However, this data set is the first of its kind to look at institution-wide involvement at this scale.

Postgraduation plans. Not surprisingly, students who engaged in UR continued their education at a higher rate compared to the university undergraduate population, although matriculation into postgraduate education does not always happen immediately (see Table 3). These rates include all forms of postgraduation education, including students seeking a second bachelor's degree (i.e., not just graduate and professional degrees). Several studies have documented that students engaged in research feel more prepared and ready for graduate education, often making plans to attend graduate school (e.g., Lopatto, 2004, 2007; Carpi, Ronan, Falcone., & Lents, 2007). Yet tracking of these students is rare.

Table 3. Five-year student success indicators.

Indicator	**Population**	**2015–2016**	**2016–2017**	**2017–2018**	**2018–2019**	**2019–2020**	**Average**
Average GPA by degree year	UCF	3.26	3.26	3.29	3.32	3.32	3.29
	UR	3.46	3.51	3.50	3.53	3.53	3.51
Average time to degree (years)	UCF	4.27	4.26	4.21	4.18	4.17	4.22
	UR	4.10	4.05	4.19	4.07	4.1	4.10
Subsequent enrollment after graduation	UCF	37.1%	34.7%	29.1%	20.8%	8.3%	16.1%
	UR	51.5%	49.8%	45.7%	35.3%	16.5%	32.7%

Note. GPA = grade point average; UCF = University of Central Florida and refers to the total undergraduate population; UR = undergraduate research and refers to the population of students engaged in UR.

Table 4. FTIC students' 4-year graduate rates.

Population	**2011–2012**	**2012–2013**	**2013–2014**	**2014–2015**	**Average**
UCF	40.4%	43.6%	43.7%	45.7%	43.4%
UR	54.2%	59.8%	57.6%	60.3%	58.0%

Note. FTIC = First time in college; UCF = University of Central Florida and refers to the total undergraduate population; UR = undergraduate research and refers to the population of students engaged in UR.

Strategic planning. The dashboard provides the campus with clear information necessary to make plans to close consistent gaps in student involvement. Thus, these data have been important for our own campus strategic planning. Additionally, trend data can be used for internal and external funding proposals.

One example that demonstrates the dashboard's utility focuses on bringing awareness to the transfer student engagement gap (Table 1). With a goal of reducing the gap, OUR continues to work with our transfer institutes to increase the pipeline and encourages new transfer students to connect early with the office. Additionally, new programming for transfer students has been developed through three current federally funded grants that are sponsoring research on STEM transfer student engagement in undergraduate research (e.g., Meeroff et al., 2019; Chamely-Wiik et al., this issue). The university-level data were important in securing the federal funds to implement valuable programs and study transfer student involvement.

Reducing the gap in involvement beyond STEM also remains a priority for the Office of Undergraduate Research (Table 1), which has developed new strategies to engage students in arts, social studies, and humanities (ASSH), such as targeted workshops, visits to departments, and clear inclusive review policies. For example, recently OUR started having two separate review panels for grants and summer programs—one for ASSH and one for STEM. This is shared with students and faculty, so they understand that cancer work and American history are being reviewed separately.

Next Steps

With our campus-wide database we still need to expand who we are tracking to be sure we are capturing all UR participants. Two areas we do not track are volunteers and work-study research assistants. We continue to encourage faculty to enroll students in these two categories in our directed independent research course, when appropriate. There is a zero-credit-hour option for students who are concerned about costs or credit hours. Additionally, new programs are often developed that are not tracked in our database, so checking in with deans and campus partners remains important.

With this campus-wide data we can now begin to ask more detailed questions about the value of student programs and opportunities. Since we track a variety of programs, we have the ability to dig into these questions and explore how different levels of involvement possibly lead to different outcomes as well as the effectiveness of different pipelines. For example, if students present their research zero, one, or two or more times, do they have an increased chance of matriculating into a postgraduate program? Do we see differences in student success indicators when students are involved for one, two, or three or more semesters, as shown for GPA in Fechheimer et al. (2011)? Do students who are in the thesis-writing program have an increased probability of going into a graduate program? With the data set, we now have the capability to address additional question about the undergraduate research experience.

There is a selection bias with our data set, since students who choose to do research likely already hold characteristics that lead to higher student success outcomes. It is hard to overcome this bias through our overview review of the data. However, the similarities in first-generation and Hispanic student involvement show some equalities in the opportunities on our campus.

More work needs to be done to compare the benefits of student research between disciplines. As noted here and elsewhere, non-STEM students make up over 50% of students involved in research. Many of the studies that demonstrate the benefits of UR nationally have focused on STEM students. This is often because of the funding of UR research through national grants (e.g., National Science Foundation, National Institutes of Health, Howard Hughes Medical Institute). For example, a large body of literature regarding student research impacts has been produced by the Survey of Undergraduate Research Experiences, funded by the Howard Hughes Medical Institute. Exploring these data from students at 66 institutions, Lopatto (2007) found that of the 1,135 respondents, less than 5% were non-STEM students. This demonstrates the need to understand non-STEM experiences.

Another line of inquiry not addressed in this paper is exploring the faculty mentor component. Above, we described the dashboard with faculty mentors but did not, given the focus of this article, explore the data compiled. There is a rich data set on the faculty mentors involved that is ready to be explored, which can help us understand what mentorship looks like at the campus-wide level.

Conclusions

University-level data is necessary to understand the full impact of UR. However, we are not sure how UCF compares to other universities because this type of university-level data does not exist beyond a few isolated case studies (e.g., Berke, 2008; Fechheimer et al., 2011). It would be powerful to compare the full results of our single institution with other peer institutions, to better understand our data set's meaning. We have set forth some benchmarks for comparing and contrasting in the future. Additionally, we have outlined areas of concern as new programming and structures are developed to lower the barriers to student involvement.

This work adds to a growing body of literature assessing the benefits of engagement in research including traditional student success metrics (e.g., graduation rates and GPA) and matriculation rates into graduate school. In state universities this is often linked to performance-based metrics that are linked to funding. For example, in Florida, state universities are held to performance-based funding metrics, including "percent of bachelor's graduates employed (earning $25,000+) or continuing their education" (State University System of Florida, Board of Governors, 2019). This database can show what some student success indicators look like at the university level when numerous programs and opportunities are combined. University-level data highlight the strategic importance of sustained funding for UR programming. To meet strategic and performance-based metrics, data can help drive support and resources to grow internal programming and sustain programs initially developed with external funding.

It is important to note that our data include experiences across the spectrum of student involvement. For example, the data include research assistants paid on grants who had menial tasks (i.e., maintaining stocks, data entry) and, on the other end of the spectrum, students who developed high-level honors theses or published in peer-reviewed publications. This difference in experience makes the data noisy when looking at student success metrics and matriculation in graduate school.

In conclusion, exploring the benefits and value of UR requires campuses to more systemically address how to "count" participating students. This count data allow an institution to benchmark their successes, find gaps in student involvement, and track basic student success indicators.

Acknowledgments

To maintain this campus-wide data set, many individuals have helped through the years. Within our Institutional Knowledge Management (IKM), Mykhael Walker, Michelle Parente, Linda Sullivan, and Evangeline Collado have assisted during different states of the partnership. Campus partners who compile data to be added into the database include Michael Aldarondo-Jeffries, Natalia Toro Leal, Padmini Coopamah Waldron, Ken Teter, LeeAnn Roberts, Sarah Evans, Melissa Dagley, Joshua Roney, Mary Tripp, and Debbie Reinhart. OUR would like to thank previous team members who helped develop early stages of the database, including Amelia Bickel, Shannon Colon, and Kathy Rovito. OUR would also like to thank Richard Harrison, Kyana Flores, and Emily Vernet for assisting with developing this manuscript.

References

Bauer, K. W., & Bennett, J. S. (2003). Alumni perceptions used to assess undergraduate research experience. *Journal of Higher Education, 74*(2), 210–230. https://doi.org/10.1080/00221546.2003.11777197

Berkes, E. (2008). Undergraduate research participation at the University of California, Berkeley (Research & Occasional Paper Series, CSHE.17.08). Berkeley, CA: University of California, Berkeley, Center for Studies in Higher Education.

Blockus, L. (2012). From the issue editor: The challenge of "the count." *Council on Undergraduate Research Quarterly, 32*(3), 4–8.

Carpi, A., Ronan, D. M., Falconer, H. M., & Lents, N. H. (2007). Cultivating minority scientists: Undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM. *Journal of Research in Science Teaching, 54*(2), 169–194. https://doi.org/10.1002/tea.21341

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How well do undergraduate research programs promote engagement and success of students? *CBE—Life Sciences Education, 10*, 156–163. https://doi.org/10.1187/cbe.10-10-0130

Junge, B., Quinones, C., Kakietek, J., Teodorescu, D., & Marsteller, P. (2010). Promoting undergraduate interest, preparedness, and professional pursuit in the sciences: An outcomes evaluation of the SURE program at Emory University. *CBE—Life Sciences Education, 9*, 119–132. https://doi.org/10.1187/cbe.09-08-0057

Kardash, C. A. M. (2000). Evaluation of an undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology, 92*(1), 191–201. https://doi.org/10.1037/0022-0663.92.1.191

Lancey, P. (2020). *Entering Student Survey 2019-2020*. Unpublished report, University of Central Florida, Orlando, FL.

Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science, 347*(6222), 627–633. https://doi.org/10.1126/science.1261757

Locks, A. M., & Gregerman, S. R. (2008). Undergraduate research as an institutional retention strategy: The University of Michigan model. In R. Taraban & R. L. Blanton (Eds.), *Creating effective undergraduate programs in science: The transformation from student to scientist* (pp. 11–32). New York: Teachers College Press.

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First findings. *Cell Biology Education, 3*, 270–277. https://doi.org/10.1187/cbe.04-07-0045

Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE—Life Sciences Education, 6*, 297–306. https://doi.org/10.1187/cbe.07-06-0039

Meeroff, D., Chamely-Wiik, D., Kwochka, W. R., Marques Frazier, E., Merritt, J., Aldarondo-Jeffries, M., ... Schneider, K. R. (2019). Work in progress: A transferable model to improve retention and student success in STEM through undergraduate research (NSF LEARN Consortium). In *Proceedings of the 126th American Society for Engineering Education Annual Conference and Exposition*, Tampa, FL. (2019, June)

Nagda, B. A., Gregerman, S. R., Jonides, J., von Hippel, W., & Lerner, J. S. (1998). Undergraduate student-faculty research partnerships affect student retention. *Review of Higher Education, 22*(1), 55–72. https://doi.org/10.1353/rhe.1998.0016

National Survey of Student Engagement (2007). *Experiences that matter: Enhancing student learning and success. National Survey of Student Engagement annual report 2007.* Bloomington, IN: Indiana University Center for Postsecondary Research.

National Survey of Student Engagement. (2019). *Engagement Insights: Survey Findings on the Quality of Undergraduate Education.* National Survey of Student Engagement annul report 2019. Bloomington, IN: Indiana University Center for Postsecondary Research

Ovink, S. M., & Veazey, B. D. (2011). More than "getting us through:" A case study in cultural capital enrichment of underrepresented minority undergraduates. *Research in Higher Education, 52*, 370–394.

Sadler, T. D., Burgin, S., McKinney, L., & Ponjuan, L. (2010). Learning science through research apprenticeships: A critical review of the literature. *Journal of Research in Science Teaching, 47*(3), 235–256. https://doi.org/10.1002/tea.20326

Schneider, K. R., Bickel, A., & Morrison-Shetlar, A. I. (2015). Planning and implementing a comprehensive student-centered research program for first-year STEM undergraduates. *Journal of College Science Teaching*, *44*(3), 37–43.

Schneider, K. R., Sullivan, L., & Collado, A. (2016). A centralized undergraduate research database: A collaboration between institutional research and university-wide research programs. *Council on Undergraduate Research Quarterly*, *36*(4), 19–25. https://doi.org/10.18833/curq/36/4/6

Schneider, K. R., Tripp, M., Nair U., Straney, R., & Lancey, P. (in press). First-year STEM research program facilitates long-term academic success. *Journal of College Science Teaching*.

Sell, A. J., Naginey, A., & Stanton, C. A. (2018). The impact of undergraduate research on academic success. *Scholarship and Practice of Undergraduate Research, 1*(3), 19–29. https://doi.org/10.18833/spur/1/3/8

State University System of Florida Board of Governors. (2019, November). *Performance funding model overview*. Retrieved from https://www.flbog.edu/wp-content/uploads/Overview-Doc-Performance-Funding-10-Metric-Model-Condensed-Version-1.pdf

Thompson, J. J., Conaway, E., & Dolan, E. L. (2016). Undergraduate students' development of social, cultural, and human capital in a networked research experience. *Cultural Studies of Science Education, 11*, 959–990. https://doi.org/10.1007/s11422-014-9628-6

Webber, K. L., Fechheimer, M., & Kleiber, P. B. (2012). Defining and measuring participation in undergraduate research at the University of Georgia. *Council on Undergraduate Research Quarterly, 32*(3), 15–17.

Wilson, Z. S., Holmes, L., de Gravelles, K., Sylvain, M. R., Batiste, L., Johnson, M., . . . Warner, I. M. (2012). Hierarchical mentoring: A transformative strategy for improving diversity and retention in undergraduate STEM disciplines. *Journal of Science Education and Technology, 21*, 148–156. https://doi.org/10.1007/s10956-011-9292-5

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 120-130.
doi: 10.14434/josotl.v21i1.30554

Using IRB Protocols to Teach Ethical Principles for Research and Everyday Life: A High-Impact Practice

Kathy L. Ritchie
Indiana University South Bend
Kritchie@iusb.edu

Abstract: Undergraduate research as a high-impact practice demonstrates many positive benefits for students, but little research has delved into the impact of ethical training for research, in particular submitting Institutional Review Board (IRB) protocols to determine if the study meets ethical standards for the treatment of human subjects. This study explored if students in two experimental and one nonexperimental research methods class benefited from increased knowledge of research ethics and how to apply them in daily-life situations if they participated in various aspects of IRB protocol procedures either as part of a class-based research project or by completing an IRB protocol activity for developing a hypothetical program to help families. Some students in all three classes had previously engaged in a 4-hr online extended training [the Collaborative Institutional Training Initiative (CITI) Program] in research ethics focused on the Belmont Report principles of beneficence, respect, and justice, but not in IRB protocols. Students were given a pre- and posttest to assess knowledge in both research and daily-life settings for applying the Belmont Report research ethics principles. Results indicate students gained greater knowledge of research ethics when they completed IRB protocol training during a class-based undergraduate research or program-design project, even if they had already completed some extended case-based training in the CITI Program. Results are discussed in terms of the value of using modified IRB protocol approaches as a high-impact practice to teach ethics in research and daily life to students.

Keywords: undergraduate research, ethics, Institutional Review Board protocols.

High-impact practices (HIPs) generally refer to a group of 11 practices designed to increase student engagement in the learning process and involvement with faculty by promoting active, hands-on activities in a collaborative and mentored environment that lead to deep and extended dives into the material and skills to be learned (Kuh, 2008; Kuh, O'Donnell, & Schneider, 2017). They include activities such as learning communities, study abroad programs, senior capstone experiences, writing-intensive courses, participation in undergraduate research, and others.

Increasingly, undergraduate research is being highlighted as an important opportunity for learning through an HIP (Kuh, 2008) by engaging students in faculty-led research and encouraging students to develop their own research projects in independent studies and senior capstone projects. This HIP can also involve introducing research into existing course instruction through course-based undergraduate research experiences (CUREs; Brownell & Kloser, 2015; Corwin, Graham, & Dolan, 2015; Segarra & Gomez, 2014; Teixeira-Poit, Cameron, & Schulman, 2011). Research on undergraduate research and CUREs has shown that students benefit from this mentored experience through increased knowledge and skill acquisition (Adedokun et al., 2014; John & Creighton, 2011; Stanford, Rocheleau, Smith, & Mohan, 2017), feelings of achievement in project ownership and self-efficacy (Adedokun et al., 2014; John & Creighton, 2011; Sandquist, Cervato, & Ogilvie, 2019), higher retention and graduation rates (Stanford et al., 2017), and greater commitment to the profession (Adedokun et al., 2014 ; Helm, & Bailey, 2013). Corwin et al. (2015) noted several benefits specifically of CUREs in their review of research on outcomes, including strong support for increased student perception in content knowledge, technical skills, and analytical abilities, in addition to some increased perceived improvement in collaboration and communication skills. There is also evidence that students were more likely to persist in science education and professions. Moreover, there is some evidence students think CUREs give them increased access to faculty as mentors and allies (Alkaher & Dolan, 2014; Kallgren & Tauber, 1996). Though much of this research focuses on research processes, lab skills, commitment to education, and critical thinking abilities, it can also impact students learning about responsible conduct in research and ethical treatment of participants.

However, even in the social sciences, the focus in undergraduate research is often on the overall research process rather than on how the research helps students learn about ethical treatment of subjects. Moreover, guidelines developed by the American Psychological Association (APA, 2013, p. 26) highlight the need to teach students not only how to "apply ethical standards to evaluate psychological science" but also how to develop "positive personal values" and "treat others with civility." Yet, most undergraduate psychology students receive superficial instruction in primarily research methods courses, focused mostly on a few cases of unethical research (Ruiz & Warchal, 2014). This instruction hardly leads to the deep understanding and change in values promoted by the APA guidelines, much less the highly integrative and mentored activities promoted by HIPs. In fact, instruction that is integrated throughout the curriculum (Ruiz & Warchal, 2014), uses extended complex case-based approaches (Watts, Medeiros, Mulhearn, Steele, Connelly, & Mumford, 2017) and uses critical thinking processes for teaching ethics (Kienzler, 2001) is needed and has been shown to be most effective in promoting knowledge of ethical and responsible research conduct.

CUREs are one way to give students this intensive HIP instruction that can lead to better critical thinking processes in research ethics (Kienzler, 2001; Olszewski, 2019). Particularly, I propose teaching students research ethics by having them actually follow the process used by scientists, such as preparing an Institutional Review Board (IRB) protocol for research with human subjects (Hubbard & Ritchie, 1995; Olszewski, 2019). IRB protocols require researchers to address each of the three principles from the Belmont Report on research ethics with humans by answering a series of questions to determine if research participants are being treated ethically. These include beneficence, which encourages researchers to consider how to maximize benefits while minimizing the harm of research participation; respect, which emphasizes the need to consider research participants as autonomous in the decision-making process and has led to guidelines for obtaining informed consent and avoiding coercion of participants; and justice, which holds researchers to fairness and lack of bias, focusing on protecting subjects from exploitation. Each of these principles requires critical thinking about how researchers can treat participants ethically while developing the study protocol and methodology. But undergraduate students have rarely been involved in this early stage of research development and thus have not benefited from the critical analysis and hands-on experience of preparing such protocols.

More instructors have been turning to these hands-on experiences, including writing and defending IRB-like protocols, when teaching research ethics (e.g., Danowitz, Brown, Jones, Diegelman-Parente, & Taylor, 2016; Diaz-Martinez, et al., 2019; Kallgren & Tabuer, 1996; Olimpo, Diaz-Martinez, Bhatt, & D'Arcy, 2017; Olszewski, 2019; Segarra & Gomez, 2014). The few existing studies on the benefits of using IRB-like procedures have shown that students reported an appreciation for ethical issues (Kallgren & Tabuer, 1996) and were more likely to address issues of informed consent and risks to participants in study design (Segarra & Gomez, 2014). Interestingly, Mabrouk (2016) found students who were involved in undergraduate research activities may tend to understand ethical concepts but not necessarily be able to apply them to their own research. In addition, Olimpo and colleagues (2017) in their review of ethics instruction reported on several studies showing few outcomes for ethical understanding due to the limited amount of time and depth given to research ethics instruction. On the other hand, using IRB protocols to teach research ethics is a mentored experience requiring greater depth than just a few hours of instruction. Olszewski (2019) argued that completing IRB protocols will help students learn not only ethical research conduct and professional skills, but also how to manage large projects. In addition, he pointed out that participating in the IRB review process develops the professional skills necessary for dealing with issues of data security, client confidentiality, and social justice as well as recognizing both risks and benefits when making decisions. The process of completing an IRB protocol under the tutelage of a faculty member would give students a more mentored and in-depth experience in learning professional ethical practices. Using IRB protocol development as a tool to teach research ethics would be consistent with the view that HIPs lead students to experiential, active, applied, and mentored learning environments that delve deeply into content and are extended over time (Kuh, 2008). Thus, involvement in actually making ethical decisions in an IRB protocol should increase not only the students' knowledge and understanding of research ethics, but also the ability to apply them beyond classroom environments and to their own research, and perhaps even to their daily life and future profession.

Though IRB procedures differ across institutions, they share certain criteria that make researchers, and thus students, think critically about beneficence, respect, and justice as they write in-depth procedures for their studies. These critical analyses and writing components are essential to HIPs (Kuh, 2008). These three principles also figured prominently in Hudson and Diaz Pearson's (2018) qualitative research into how college students think about morality. They noted that elements of respect, doing no harm, and justice were 3 of 10 themes identified as important to college students' moral identities. Thus, the IRB protocol should relate well to students' own moral perspective, making it easier for students to apply it to everyday moral decisions, which might eventually lead students to further develop their own ethical and moral standards in life. The IRB protocols at our institution for all research projects include both an online, in-depth exposure to classic studies and instruction on research ethics similar to those reported by Olimpo and colleagues (2017), as well as writing critical responses to multiple questions about the three Belmont Report research ethics principles (BREPs), addressing the topics of study procedures, risks and benefits, data security, informed consent, and others.

Another component of completing IRB protocols for CUREs is that they are grounded by a relationship with the course instructor, who then can serve as a mentor to help students better understand how the three BREPs apply to their own projects. In fact, there is some evidence suggesting students do receive greater mentorship through CUREs, leading to a greater appreciation of research ethics (Kallgren & Tauber, 1996). Students often work with the instructor as they make decisions, receive feedback, and make changes to their protocols.

This study arose from my normal assessment practices to determine teaching effectiveness in research methods classes. In these classes, I use various forms of IRB protocol development to give students that hands-on experience. I developed three hypotheses based on findings from using undergraduate research experiences generally, as well as those specific to learning ethics within a classroom environment using undergraduate research (e.g., Kallgren & Tauber, 1996; Olimpo et al., 2017). First, I expected students would learn from traditional methods of class discussion of core cases, but greater learning would occur from the more in-depth process of IRB training workshops and on-line modules. At our institution, this was completed using the Collaborative Institutional Training Initiative Program (CITI Program, 2019) an approximately 4-hr on-line training program. Second, I hypothesized that students would achieve even greater learning of ethical principles from IRB mentored experiences, especially if they had in-depth traditional training from the CITI Program previously. Last, I expected that students would gain a greater ability to understand how research ethical principles apply to daily-life issues after IRB protocol training.

Method

Participants

Data were collected from students (*n* = 97) across two semesters from three different types of classes at a Midwestern regional campus, whose student body is mostly female, traditional-aged, Caucasian students. At this campus, 65% of the students are women, 28% are minorities, and 72% are under the age of 24. In addition, 79% of the undergraduate students are full-time, but only 8% of students live on campus. The majority of students graduated from high schools close by.

The first type of class was a sophomore-level course designed to introduce students to basic experimental methods (EXP) and APA format for writing manuscripts. Three to four students complete an extensive group project designed to teach the mechanics of research in psychology, including ethical procedures. As part of the group project, students collectively complete an IRB protocol that is not submitted to an IRB committee but is closely mentored by the instructor. Over two semesters, 31 students took this class, only two of whom had completed previous CITI training. The second type of class focused on teaching nonexperimental methods of psychological and professional research (NONEXP) to mostly advanced students roughly 1 year from graduation. There were 35 students from two semesters, and a majority had completed CITI training (*n* = 26), either to work in a professor's research lab or in an earlier class. In this class, students completed data collection for a qualitative interview project on how family spaces (e.g., family and living rooms) impact family cohesion. As part of this project, students completed training on an IRB-approved protocol closely mentored by the instructor, typical but much more in-depth compared to how students would normally be trained as research assistants in a professor's lab. Groups of students used the existing IRB protocol to answer questions about the three Belmont Report principles and how the study safeguards the rights of participants under each principle. Last, one section of an upper division interdisciplinary psychology course in marriage and family (MF), which completed group projects to design a hypothetical program to serve at-risk families, was included for comparison (*n* = 31); six of these students had completed previous CITI training. These students were required to use questions similar to those of an IRB protocol to demonstrate the ethical treatment of potential clients.

Materials

Testing materials. Materials included a pre- and posttest as well as an in-class exam. The pre- and posttest consisted of the same 10 multiple-choice questions for measuring knowledge of the BREPs but were administered without announcement a little over 3 months apart. Some questions required students to distinguish between the definitions of the principles, but most required the student to think critically while applying the principles to hypothetical research scenarios. These questions changed between the classes. Students received one point for each correct answer. All versions of the testing materials had at least three questions each for justice and beneficence but had four questions for respect. An example of a question assessing knowledge of respect for research ethics is "Hayden carefully administers informed consent of his subjects because he wants to make sure they are making an autonomous decision about whether to participate or not. He is observing which principle of the Belmont Report?" Students then chose between beneficence, justice, or respect as the answer. An example of a question about beneficence is "T'rshelle completes a section of an IRB protocol which asks her to name all the risks to her subjects as well as any direct rewards they might receive from participating in the research. She is working on this ethical principle."

The in-class exams were similar in nature but often did not have 10 questions, and thus these scores were reconfigured to a 10-point scale. Usually, there were six to eight questions on these tests. The questions concerning applications of the BREP to daily life were also similar, though there were four questions for respect, four for justice, and three for beneficence, resulting in a total of 11 questions. Like the in-class exams, the daily-life answers were rescaled to 10 points. An example of a justice question from the daily life-scale is "A wise boss tries to make decisions based on what is best for all his or her employees rather than playing favorites. Bosses who show favoritism at the cost of others are breaking this basic principle."

Modified IRB protocol. The IRB protocol for the NONEXP students was the one already approved by the IRB, but training students on the approved protocol was achieved by having students answer questions in small groups of three or four students, similar to the modified IRB protocol used by EXP students for their group projects, while the instructor circulated among these groups. The modified protocol for MF students was similar except the questions related to design, implementation, and safeguarding data gathered for a program rather than a research study. EXP students were placed in groups of three or four students to design their research projects and complete the modified IRB protocol across two class sessions. This protocol began by having students write a brief description of their proposed study purpose and procedures. Then, students listed potential risks to participants and methods they would use to minimize these risks. Students also listed potential benefits for participants. These questions focused on the beneficence principle. Students also answered questions about participant recruitment. Since most students were going to use friends and family, they were required to justify this procedure and how they would safeguard the confidentiality of the participant as well as how they would minimize potential coercion to do the research. Students wrote out a recruitment script and prepared the informed consent form that they planned to use. These questions mostly focused on the respect principle. One question specifically required students to address the potential vulnerability of their participants to being exploited since they often used friends and family. This addressed issues of justice. Students also answered questions concerning how they would manage the data collected and maintain the confidentiality of their participants. These protocols were submitted to the instructor, who made comments that students then responded to as a group in the next class meeting. NONEXP students answered questions about the existing IRB-approved protocol in small groups focused on how they would specifically complete their part of the research project. Last, the modified IRB protocol for the MF students was similar, though participant recruitment did not focus on family and friends but rather on community agencies. The protocol also still focused on how students would collect and safeguard data from program participants.

Instructional Procedures

In each class, I began with a knowledge pretest to assess prior exposure to the BREPs; the methodology classes (EXP and NONEXP) also answered questions about how to apply these principles to everyday moral issues. This pretest was administered within the first week of class prior to research ethics instruction. Then, I taught students using a typical approach of introducing the three principles from the Belmont Report and how they were developed from standard examples of problematic studies, many of which were discussed in detail in their textbooks. Key studies discussed include the Milgram Study and the Tuskegee Institute Study in terms of how they gave rise to the three principles. This information was usually covered in one class period, approximately in the second or third week. Students were then tested on knowledge of these principles for research, but not everyday moral issues, in standard in-class exams using multiple-choice questions. Then, I showed students how these principles are addressed in IRB protocols, approximately in the fifth week of class. EXP students wrote parts of a protocol for a group research project on various topics, while NONEXP students discussed in detail an existing IRB protocol concerning a qualitative study on how families use family spaces such as the family room to enhance family cohesion and bonding, which the students implemented as part of the class. MF students, also in small groups, completed the modified IRB concerning development of a program for at-risk families. These procedures took at least two class periods. Students in the methods classes then completed the research from approximately Week 5 to Week 12. MF students presented their projects to the class near the end of the term. Last, students were given a posttest at the end of the semester (the 16^{th} week) to retest their knowledge of both the BREPs and their application to everyday moral issues.

Archival Research Procedures

Data gathered from students were used as a classroom assessment to increase the effectiveness of my instruction. Aggregate assessment results across the entire class were then shared with students via a class management software (Canvas) announcement only after I had completed the term and turned in their grades. At that point, their names and identifying information had already been stripped from the class data file to complete the aggregate assessment. These assessment results were used to make changes to the class and reported in my annual evaluations. About a year later, I had an exempt IRB protocol approved to combine these class de-identified data sets into one data set to analyze as an archival database to answer the research question of whether these IRB protocol procedures increased student knowledge of ethical research principles. These analyses were presented at a conference for educators (Ritchie, 2015) approximately 4 years ago.

Results

Analyses were conducted using three different repeated measures analyses of variance (ANOVAs), which I discuss in conjunction with the three hypotheses.

Does Greater Learning Occur After In-Depth Traditional Training?

The first hypothesis was that traditional methods of instruction would be related to greater understanding of the BREPs, but especially when that instruction was in greater depth congruent with the training necessary for submission of IRB protocols through CITI training. BREP test results for 97 students were submitted to a 2 (test times) × 2 (CITI training [with or without]) × 3 (courses) repeated measures ANOVA. For research knowledge questions, a significant effect was found for test time, $F(1,91) = 30.04$, $p < .001$. As shown in Figure 1, over all three classes, students showed improvement from the pretest ($M = 4.36$, $SD = 2.14$) to the posttest ($M = 6.25$, $SD = 2.35$). In addition, those with CITI training scored better across the two tests compared to those without CITI training regardless of which class they were in, $F(1,91) = 8.68$, $p = .004$. No other significant effects were found.

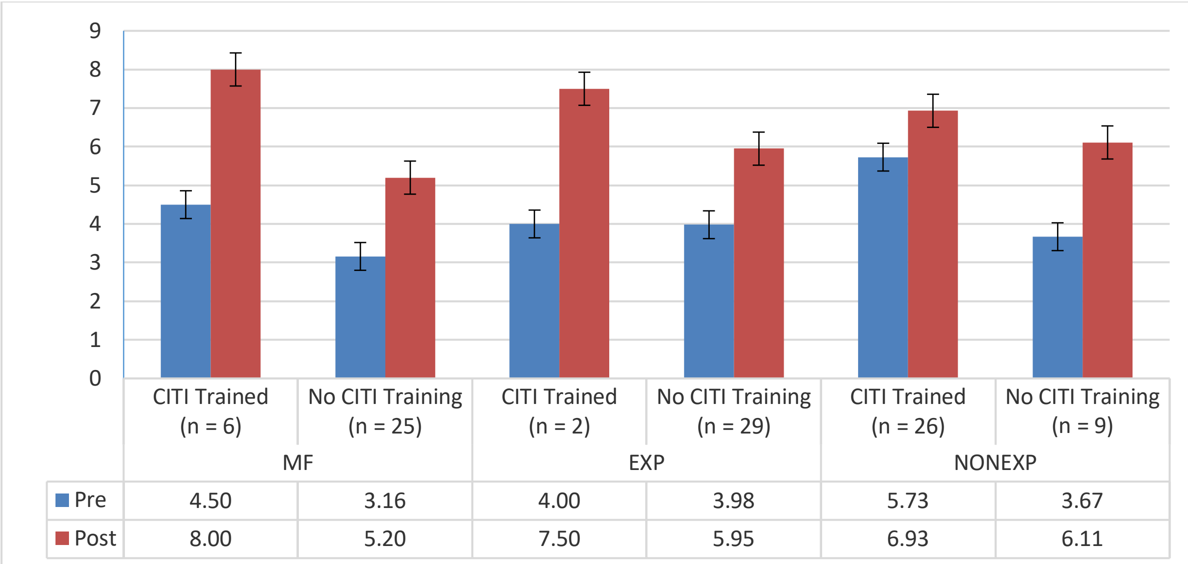

Figure 1. Means for pre- and posttest scores by class and training. CITI = Collaborative Institutional Training Initiative Program; EXP = class on basic experimental methods; MF = class on marriage and family; NONEXP = class on nonexperimental methods of psychological and professional research. All three classes used Institutional Review Board protocols to teach ethical principles. Error bars are represented.

Does Greater Learning Occur with IRB Mentored Activities?

For one section of the EXP class, data were available not only from the pre- and posttest but also from an in-class test that followed traditional instruction but was given before IRB training and protocol development began. Fourteen students participated in this class and their data were submitted to a repeated measures one-way ANOVA on training type (pre-IRB-training, traditional instruction, and post-IRB-training), followed by post hoc paired samples t tests. A significant effect of training type was found, $F(2,26) = 4.66$, $p = .019$. Post hoc t tests indicated that post-IRB-training ($M = 5.59$, $SD = 1.74$) differed significantly from pre-IRB-training ($M = 3.41$, $SD = 1.27$), $t(13) = -3.86$, $p = .002$, and tended to differ from traditional instruction ($M = 4.04$, $SD = 2.57$), $t(13) = -1.95$, $p = .073$. There was no difference between pre-IRB-training and traditional instruction, $t(13) = -.77$, $p = .455$.

Are These Learning Effects Transferable to Everyday Ethical Issues?

Two research methods sections (EXP: $n = 22$; NONEXP: $n = 14$) also completed a measurement on applying the BREPs to everyday-life decisions as both a pretest and a posttest. Data were submitted to a 2 (test times) × 2 (courses) repeated measures ANOVA and resulted in a significant difference for test time, $F(1,34) = 16.46$, $p < .001$. Both sections scored better on applying the BREPs to everyday-life decisions after IRB training ($M = 5.53$, $SD = 2.28$) than in the pretest ($M = 6.95$, $SD = 2.19$). There was no main effect of course.

Discussion

The data demonstrate that a modified IRB protocol experience within a CURE is associated with increased understanding of the three BREPs and how to apply them to everyday-life experiences. This result is consistent with previous findings showing that such experiences were associated with greater appreciation of ethical research principles (Kallgren & Tauber, 1996) and issues of informed consent and participant risks (Segarra & Gomez, 2014). The current investigation demonstrated that a mentored IRB-like activity was related to increased knowledge of ethical research issues as proposed by Hubbard and Ritchie (1995) as well as Olszewski (2019). In addition, the modified IRB protocol procedure for program development was also related to increased knowledge of ethical principles for a nonmethods MF class.

There are many reasons why using IRB protocols would yield these results. First, undergraduate research experiences have been related to greater discipline-specific knowledge generally (e.g., John & Creighton, 2011; Stanford et al., 2017), and responsible conduct and research ethics is one such area of discipline-specific knowledge. Thus, general benefits of increased discipline-specific knowledge of undergraduate research might yield increased understanding of the BREPs. Yet, given that HIPs also show positive benefits for undergraduates in skills and knowledge, it could be the results are an effect of such practices rather than the use of the modified IRB protocols. Moreover, because a highly mentored procedure was used with faculty feedback giving rise to reflective changes in study design, these results could have been due to increases in faculty input and engagement on the student project, typical in such mentor relationships. Still, the modified IRB protocol follows procedures that may encourage greater knowledge and mentorship specifically because of the nature of the process itself. Students engage in active, experiential learning in which they must clearly communicate through writing a professional document justifying their decisions based on applying the BREPs. They then must consider adjustments to their study in light of specific feedback given by the instructor in a process very similar not only to IRB procedures for research but to practices in professional settings as well. This procedure, unlike traditional methods that focus on teaching what *not* to do by analyzing ethically problematic studies, focuses on teaching students what to do using a positive framework for critical analysis of ethical decisions. In addition, this procedure encourages the extended complex case-based ethical instruction that leads to better knowledge of research ethics (Watts, et al., 2017).

Though not in this study, faculty mentorship through an IRB-like protocol should improve not only knowledge of ethical principles but also the quality of the student research projects. Future research should investigate if the use of such protocols leads to better student projects, as has been suggested by research on CUREs. For example, Corwin et al. (2015) found benefits of such course-based research projects for student perceptions on technical skills, analytical abilities, teamwork, and communication. Conceivably, these perceived benefits of undergraduate research would also include using IRB protocols to sharpen the project and ensure ethical procedures, leading to higher quality projects and better student outcomes. Furthermore, this mentored experience also corresponds to the types of professional communications and processes that students will encounter in their future careers. Engaging students in an IRB-like process to develop projects in the MF class did increase ethical knowledge of the BREPs. Since not all areas of research and many professions do not use IRB processes, modifying the process used in the MF class to include other ethical principles could lead not only to greater ethical knowledge but perhaps also to ethical professional behavior generally and better student projects overall.

There are, of course, limitations to these findings. The current study was quasiexperimental; it was not possible to randomize either which students would receive the modified IRB training or in what order that training would be given. Not only must caution be taken in concluding a causal relation between the modified IRB training and increased student knowledge, but students could have simply improved because they were getting increased instruction, regardless of the type of instruction. In fact, the pre- and posttest, though separated by 3 months, contained the same questions. Though students were unaware that there would be a posttest, previous exposure could have led to increased scores. Last, because the investigation was completed within a classroom environment, student motivation to excel could have impacted the results, much like a placebo effect. Moreover, the investigation did not track students over a long period of time. It could be that the increased knowledge fades over time rather than having a lasting impact. Nor is it possible to know from the results of applying the BREPs to everyday-life experiences if the increased knowledge will have an impact on students' actual ethical and moral behavior. Further research should extend beyond one class term to explore if the knowledge persists and affects actual behaviors. In fact, investigations of how these research experiences impact future professional behaviors would be beneficial.

There are also some practical issues of note. First, individual IRBs may differ in their procedures and interpretations of what constitutes research. Thus, many projects led by undergraduate students within courses might be deemed "not research" because they would not add to greater knowledge within the field; this is the case at my own institution. In such cases, instructors may need to think in more creative ways to introduce IRB-like procedures into instruction (see Olszewski, 2019), including the use of modified proposals, classroom review panels, blind peer reviews of proposals by faculty and other students, and others tactics. Moreover, a modified IRB protocol can be easily adapted for use in other, nonmethodology classes in which students propose programs or projects that still collect data even though the projects are not specifically research for basic knowledge but rather for internal use within a program or agency, as was the case for the MF class in this investigation. In addition, the IRB process could provoke frustration and stress in students who are on a timetable and have not experienced such a sometimes legalistic, negotiated process of decision making and professional correspondence. However, these types of decision-making processes are common in professional settings, and using the IRB process to mentor students may lead to students' better understanding of working with teams and other professional groups, giving them insight into how to effectively navigate professional dilemmas as well as a way to sharpen their professional demeanor and communication skills. Future research should explore if IRB-like procedures improve teamwork and communication.

Though there are some limitations to causal pathways as well as practical issues to consider, the results demonstrate that student knowledge increased with both in-depth traditional case-based instruction on the BREPs and then showed growth in knowledge after a modified IRB protocol training. Further research should explore how this knowledge might persist into professional settings both in terms of applying the BREPs and if this increased knowledge is associated with more professional ethical conduct and behavior as well as teamwork skills. These findings, however, do suggest that using the modified IRB protocol procedure described in this investigation and perhaps those suggested by others might be beneficial to the ethical conduct of research and perhaps students' future professional lives.

References

Adedokun, O. A., Parker, L. C., Childress, A., Burgess, W., Adams, R., Agnew, ... Teegarden, D. (2014). Effect of time on perceived gains from an undergraduate research program. *CBE—Life Sciences Education*, *13*(1), 139–148. https://doi.org/10.1187/cbe.13-03-0045

Alkaher, I., & Dolan, E. L. (2014). Integrating research into undergraduate courses: Current practices and future directions. In D. W. Sunal, C. S. Sunal, E. L. Wright, C. L. Mason, & D. Zollman (Eds.), *Research based undergraduate science teaching* (pp. 403–434). Charlotte, NC: IAP Information Age Publishing.

American Psychological Association. (2013). *APA guidelines for the undergraduate psychology major*: *Version 2.0*. Retrieved from http://www.apa.org/ed/precollege/undergrad/index.aspx

Brownell, S. E., & Kloser, M. J. (2015). Toward a conceptual framework for measuring the effectiveness of course-based undergraduate research experiences in undergraduate biology. *Studies in Higher Education*, *40*(3), 525–544. https://doi.org/10.1080/03075079.2015.1004234

CITI Program. (2019, November 27). *Indiana University/IU Health: Social and behavioral researchers*. Retrieved from https://www.citiprogram.org/members/index.cfm?pageID=50

Corwin, L. A., Graham, M. J., & Dolan, E. L. (2015). Modeling course-based undergraduate research experiences: An agenda for future research and evaluation. *CBE—Life Sciences Education, 14*(1), es1. https://doi.org/10.1187/cbe.14-10-0167

Danowitz, A. M., Brown, R. C., Jones, C. D., Diegelman-Parente, A., & Taylor, C. E. (2016). A combination course and lab-based approach to teaching research skills to undergraduates. *Journal of Chemical Education*, *93*(3), 434–438. https://doi.org/10.1021/acs.jchemed.5b00390

Diaz-Martinez, L.A., Fisher, G. R., Esparza, D., Bhatt, J. M., D'Arcy, C. E., Apodaca, J., ... Olimpo, J. T. (2019). Recommendations for effective integration of ethics and responsible conduct of research (E/RCR) education into course-based undergraduate research experiences: Meeting report. *CBE—Life Sciences Education, 18*(2), mr2. https://doi.org/10.1187/cbe.18-10-0203

Follmer, D. J., Zappe, S., Gomez, E., & Kumar, M. (2017), Student outcomes from undergraduate research programs: Comparing models of research experiences for undergraduates (REUs). *Scholarship and Practice of Undergraduate Research, 1*(1), 20-27. https://doi.org/10.18833/spur/1/1/5

Helm, H. W., Jr., & Bailey, K. G. D. (2013). Perceived benefits of presenting undergraduate research at a professional conference. *North American Journal of Psychology*, *15*(3), 527–536.

Hubbard, R. W., & Ritchie, K. L. (1995). The human subjects review procedure: An exercise in critical thinking for undergraduate experimental psychology students. *Teaching of Psychology, 22*(1), 64–65. https://doi.org/10.1207/s15328023top2201_19

Hudson, T. D., & Diaz Pearson, A. (2018). Developing the moral self: College students' understandings of living a moral or ethical life. Journal of College & Character, 19(3), 185-200. https://doi.org/10.1080/2194587X.2018.1481096

John, J., & Creighton, J. (2011). Researcher development: The impact of undergraduate research opportunity programmes on students in the UK. *Studies in Higher Education, 36*(7)*,* 781–797. https://doi.org/10.1080/03075071003777708

Kallgren, C. A., & Tauber, R. T. (1996). Undergraduate research and the institutional review board: A mismatch or happy marriage? *Teaching of Psychology*, *23*(1), 20–25. https://doi.org/10.1207/s15328023top2301_3

Kienzler, D. (2001). Ethics, critical thinking, and professional communication pedagogy. *Technical Communication Quarterly*, *10*(3), 319–339. https://doi.org/10.1207/s15427625tcq1003_5

Kuh, G. (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., O'Donnell, K., & Schneider, C. G. (2017). HIPs at ten. *Change*, *49*(5), 8–16. https://doi.org/10.1080/00091383.2017.1366805

Mabrouk, P. A. (2016). What knowledge of responsible conduct of research do undergraduates bring to their undergraduate research experiences? *Journal of Chemical Education*, *93*(1), 46–55. https://doi.org/10.1021/acs.jchemed.5b00264

Olimpo, J. T., Diaz-Martinez, L. A., Bhatt, J.M., & D'Arcy, C.E. (2017). Integration of RCR and ethics education into course-based undergraduate research experiences in the biological sciences: A needed discussion. *Journal of Microbiology and Biology Education, 18*(2), 1-8. https://doi.org/10.1128/jmbe.v18i2.1344

Olszewski, T. M. (2019). Bringing the IRB into the classroom: Promoting research and professional socialization in undergraduate education. *Journal on Excellence in College Teaching*, *30*(3), 161–177.

Ritchie, K. L. (2015, October). *Using IRB protocols to teach ethical principles*. Poster presented at the Lilly Conference. Traverse City, MI.

Ruiz, A., & Warchal, J. (2014). Ethics as an undergraduate psychology outcome: When, where and how to teach it. *Psychology of Learning & Teaching, 13*(2), 120–128. https://doi.org/10.2304/plat.2014.13.2.120

Sandquist, E. J., Cervato, C., & Ogilvie, C. (2019). Positive affective and behavioral gains of first-year students in course-based research across disciplines. *Scholarship and Practice of Undergraduate Research*, *2*(4), 45–57. https://doi.org/10.18833/spur/2/4/9

Segarra, I., & Gomez, M. (2014). A learning activity to introduce undergraduate students to bioethics in human clinical research: A case study. *Journal of Empirical Research on Human Research Ethics, 9*(5), 56–63. https://doi.org/10.1177/1556264614557238

Stanford, J. S., Rocheleau, S. E., Smith, K. P. W., & Mohan, J. (2017). Early undergraduate research experiences lead to similar learning gains for STEM and non-STEM undergraduates. *Studies in Higher Education*, *42*(1), 115–129. https://doi.org/10.1080/03075079.2015.1035248

Teixeira-Poit, S. M., Cameron, A., & Schulman, M. D. (2011). Experiential learning and research ethics: Enhancing knowledge through action. *Teaching Sociology, 39*(3), 244–258. https://doi.org/10.1177/0092055X11407346

Watts, L. L., Medeiros, K. E., Mulhearn, T. J., Steele, L. M., Connelly, S., & Mumford, M. D. (2017). Are ethics training programs improving? A meta-analytic review of past and present ethics instruction in the Sciences. *Ethics & Behavior, 27*(5), 351–384. https://doi.org/10.1080/10508422.2016.1182025

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 131-151.
doi: 10.14434/josotl.v21i1.30353

Undergraduate Research at a Teaching-Oriented College: Seniors' Perspectives and Approaches to Consider

Robin Herlands Cresiski
University of Maryland, Baltimore County
rcresisk@umbc.edu

Qingmin Shi
University of Nevada, Las Vegas

Sandip Thanki
Nevada State College

Lori Navarrete
Nevada State College

Abstract: This study examines the relationship of undergraduate research (UGR) participation on senior students' reported engagement, perceived gains, satisfaction with their educational experience and retention, and graduation status compared to peers that have not participated in UGR. Data were drawn from 1,472 senior students at a comprehensive, teaching-oriented public college, and collected from administration of the National Survey of Student Engagement (NSSE) from 2015 to 2019, along with institutional data. This examination uniquely investigates outcomes of UGR participation besides persistence and graduation (which are already well documented) and leverages the lens of senior students in particular. In addition, this study contributes to the literature on UGR at teaching-oriented colleges, which has been sparse most likely because there are many more opportunities for UGR at research institutions. In line with several conceptual frameworks of student engagement, data analysis revealed that relative to their peers who have not participated in UGR, UGR-participating students have higher levels of engagement, perceived gains, and overall satisfaction. UGR-participating students also continued enrollment and/or graduated at a higher rate after reaching their senior status compared to non-participating peers. The implications for teaching-oriented colleges, as well as suggestions for how these institutions can enhance their undergraduate research programming, are discussed.

Keywords: undergraduate research, senior, National Survey of Student Engagement (NSSE), engagement, perceived gains, satisfaction

Introduction

Participation in undergraduate research (UGR, hereafter) has been well documented to have an impact on student success. Rightfully designated a high impact practice (Kuh, 2008), working on novel research with a faculty member positively impacts student retention and graduation and increases a student's self-identification as a scholar/scientist, which may be critical in persistence into graduate-level study and future career choice (Eagan et al., 2013; Lopatto, 2010; Seymour et al., 2004). These outcomes are particularly notable in racial minority and first-generation populations (Carpi et al., 2017; Hurtado et al., 2010; Jones et al., 2010; Kuh, 2008; Lopatto, 2010; O'Donnell et al., 2015), which remain significantly underrepresented in the academy. Because of the reproducible data demonstrating the impact of UGR participation, institutions should expand opportunities for undergraduate research. This is easier at some institutions than others, however.

UGR normally operates in an apprentice model: a student spends a summer or semester working significant hours under a faculty member, postdoc, or senior graduate student and often earns a stipend to do so (Lopatto, in 2010, coins this "the epitome of the undergraduate research experience"). This apprentice model is standard at research universities but is expensive in both financial and human resources since stipends are required for both mentor and mentee, and mentors typically take on just a few undergraduate mentees at a time. It is also not easily replicated at teaching colleges where faculty frequently do not have the laboratory space, support to seek grant funding for staff/equipment to conduct research, or workload accommodations that would facilitate apprentice-based research (Hu et al., 2007; Marwick, 2012). In addition, there are questions of accessibility with the apprentice model. While there has not been extensive research about why some students *do not* participate in research, some research indicates that lack of time and the low pay for conducting research contribute to the decision (Stout, 2018). Therefore, accessing apprentice opportunities outside of dedicated for-credit class time is limited for first-generation and low-income students that frequently work significant hours while in college (Falcon, 2015; RTI International, 2019). This was confirmed in the national Survey of Undergraduate Research Experiences (SURE), where nearly two-thirds of students participating in research reported difficulty balancing time between research (in the apprentice model) with coursework and other activities (Lopatto, 2010). Despite this, little research has been done examining low-income student participation in UGR or the impacts of UGR for this population.

Teaching colleges (which represent a significant portion of the higher education market as community colleges, small liberal arts colleges, and undergraduate-focused regional comprehensive universities) have had to innovate alternative models for providing research opportunities (Wei & Woodin, 2011). Research partnerships with community organizations (e.g., research internships for credit) and course-based undergraduate research experiences (CUREs) are two such mechanisms. CUREs can take place in science labs conducting novel research, statistics classrooms (for example, a class can act as consultants for community organizations), as history projects (archiving materials at a local historical site), or education courses centered around teacher-as-researcher projects (students study the efficacy of reading interventions), etc. CUREs have the advantage of engaging an entire class in research as opposed to a select few apprentices (Auchincloss et al., 2014; Bangera & Brownell, 2014), and yield similar positive results in building science identity, research skills, and intention to pursue graduate education/careers in research (Auchincloss et al., 2014; Harrison et al., 2011; Jordan et al., 2014; Shaffer et al., 2010). Students participating in class-based research also have higher skill gains than summer researchers for science writing, research ethics, and understanding primary literature (Lopatto, 2010).

Alternative forms of giving students access to research are especially important in that they are achievable at all kinds of teaching institutions, including community colleges where it is estimated that half of all college-going students get their start (Center, 2017). Community colleges have innovated a wide breadth of research opportunities for undergraduates (Cejda & Hensel, 2009; Marwick, 2012), with some emphasizing the scientific process (Brandt & Hayes, 2012), focusing on applied research in a technical area, or investigating topics/problems of local relevance (Cejda & Hensel, 2009). Importantly, the SURE data indicate that students engaging in alternative research experiences like these (compared to traditional apprentice programs) are just as likely to go to graduate school and go to graduate school at higher rates than peers who did not complete any UGR (Hathaway et al., 2002).

Despite the positive outcomes, there remains limited research on the outcomes of students engaging in UGR at teaching-focused institutions. Prior to this study, it has not been shown whether non-apprentice model UGR at teaching-focused institutions has similar impacts to student engagement, perceived gains, satisfaction or persistence/graduation, nor how these impacts manifest in populations most underrepresented in the academy. In this study, we analyzed 2015-2019 National Survey of Student Engagement (NSSE) data from senior students at a public comprehensive institution that emphasizes teaching. Senior students are a relatively untapped source of feedback that can help campus communities learn about the meaningfulness of research opportunities and the impact such opportunities have on their success (Gardner & Veer, 1998). Surveys of senior students are important because research can occur at any level of the undergraduate experience, including during the senior year (a senior capstone, thesis, internship, project, or lab experience). We sought to examine whether there were differences in seniors' level of engagement, perceived gains, and overall satisfaction for those who did and did not participate in UGR. Further, we also wanted to examine the extent to which participation in UGR impacted persistence or graduation status after reaching senior status. This examination will help us understand the impact of research in this distinct setting and provoke greater discussion of how UGR can be implemented and leveraged at teaching-focused colleges.

Methods

Study Context

The study is situated in a comprehensive public teaching-oriented college (referred to as "the Institution" hereafter). The Institution has had a steadily growing baccalaureate population, reaching over 5,000 students in fall 2019. As a highly diverse, open-access campus, the Institution received designation from the Department of Education as a Title III & Title IV Minority Serving Institution (MSI) in 2013. In 2015, the Institution achieved its designation as a Hispanic Serving Institution (HSI). In fall 2019, 75% of the enrolled students were female, 63% were from ethnic and racial minority backgrounds, and over 47% were first-generation college students. The campus had a large portion (38%) of low-income, Pell recipient students. To address the needs of such a diverse student population and all students, the Institution offers a wide range of student support initiatives, programs, and inclusive practices to assist and support students (especially traditionally underserved racial and ethnic minority, first-generation, and low-income students) and enhance the students' educational experiences. Studies like this will shed light on the benefits of participation in UGR on student engagement, perceived gains, and satisfaction, especially for traditionally underrepresented college students in teaching-oriented colleges.

Data Sources and Participants

Senior data from the Institution's 2015-2019 NSSE administrations, as well as institutional data, were used for this study. NSSE data were retrieved from NSSE through the designated institutional interface (NSSE staff administer its core survey in spring to first-year and senior-year students through a specific online survey link directly sent to eligible students and later provide each participating institution access to their data). One of the authors connected the NSSE data to the institutional data warehouse through student ID's and transferred the de-identified data to another author to conduct statistical analysis. The dataset allowed researchers to explore targeted variables related to student experiences with UGR, engagement, perceived gains, overall satisfaction, and other student success metrics.

Potential participants in this study were 1,673 senior-year students who responded to the NSSE core survey from 2015 through 2019. Of these respondents, 1,472 completed questions related to UGR and were included in the data analysis of this study. The majority of participants were female (80%), racial and ethnic minority (47%), first-generation (65%), and had received Pell support (53%).

The demographics of these NSSE seniors in this study is similar to the campus senior population of fall 2014 to fall 2018 in terms of gender (76% females), race and ethnicity (55% ethnic minority), first-generation status (64%), and receipt of a Pell grant ever in their time at the Institution (55%). Although the senior sample of this study is relatively representative of the campus senior population, caution should be practiced in interpreting and generalizing the findings.

Measurement and Variables

The NSSE core survey was used to measure senior students' participation in UGR and engagement indicators, perceived gains, and overall satisfaction (see Appendix for example items for engagement indicators, perceived gains, and overall satisfaction in NSSE survey). After a significant revision of the NSSE core survey in 2013, the NSSE core surveys of 2015 through 2019 include the same questions related to UGR, engagement, perceived gains, and overall satisfaction. This makes the items comparable year over year.

Undergraduate Research. The UGR question in NSSE was not limited to the current school year at the time of data collection; therefore, seniors' responses included their participation for all the years since they attended the college. The question asked, "Which of the following have you done or do you plan to do before you graduate?" NSSE asked students to indicate whether they have done or were in progress of working with a faculty member on a research project with four possible responses: (a) have not decided, (b) do not plan to do, (c) plan to do, and (d) done or in progress. We re-coded "d" as "1", indicating UGR participation, and "a", "b", and "c" as "0" for no UGR participation.

Engagement Indicators. Student engagement was estimated by 10 engagement indicators constructed with 47 questions, which asked students to indicate how often they have done the related activities. The question stem asked, "During the current school year, about how often have you done the following?" and then provided a list of activities, such as "combined ideas from different courses when completing assignments." The NSSE core survey designated each question with four response options (1: never, 2: sometimes, 3: often, and 4: very often).

Perceived Gains. Perceived gains were measured by 10 questions, which asked students to indicate their gains in practical competence, personal and social development, and general education competency areas as a result of their undergraduate education. The prompt asked, "How much has your experience at this institution contributed to your knowledge, skills, and personal development in the following areas?" and then had areas such as "thinking critically and analytically" and "analyzing numerical and statistical information." Each area then had four response options (1: very little, 2: some, 3: quite a bit, and 4: very much).

Overall Satisfaction. Two NSSE items were used to measure what NSSE deems "Overall Satisfaction": "How would you evaluate your entire educational experience at this institution?" and "If you could start over again, would you go to the same institution that you are attending?" Both questions had four response options (1: poor, 2: fair, 3: good, and 4: excellent; or 1: definitely no, 2: probably no, 3: probably yes, and 4: definitely yes).

In order to facilitate comparisons over time and between groups of students, scores of engagement indicators, perceived gains, and satisfaction were first converted on a 60-point scale. Then, re-coded values for each component item were calculated and averaged as a composite score for each engagement indicator. Engagement indicators were pre-calculated by NSSE, while responses of perceived gains and satisfaction questions were re-coded with values of 0, 20, 40, or 60, for 1, 2, 3, and 4, respectively, following NSSE-recommended SPSS syntax (NSSE, n.d.). The higher scores mean more frequent engagement, more perceived gains, and high-level satisfaction.

Persistence or Graduation Status. We also collected two variables of persistence or graduation status drawn from institutional data for this study. First, we used persistence as one of the indicators of senior student success, measured by a student *either* having graduated by summer after reaching senior status and completing the NSSE survey *or* continuing enrollment in the next fall at the Institution. A student either having graduated from or re-enrolled in the next fall at the Institution was coded as "1" for "persisted". Otherwise, the student was coded as "0" for "not persisted". Second, we included an institutional variable of "graduated by summer after reaching senior status and completing the NSSE survey" (senior status meaning the cumulative credit hours reached 90). Since these senior participants started their undergraduate career at different years, we believe that it is a fair comparison of graduation status after reaching senior status. Students were coded a "1" for "graduated by summer after reaching senior status and completing the NSSE survey" or a "0" for "not graduated by summer after reaching senior status and completing the NSSE survey." This data was evaluated by minority status, first generation status, and low-income status. We defined minority as Black or African American, Hispanics of any race, Asian, two or more races, Native Hawaiian or other Pacific Islander, and American Indian or Alaska Native based on the Integrated Postsecondary Education Data System (IPEDS) definition. Those whose race and ethnicity was unknown were excluded from the analysis. First-generation students are those with neither parent having graduated with a bachelor's degree from a 4-year college or university. Low-income students are those who have ever received a Pell Grant based primarily on the student's or parents' income for the previous year.

Data Analysis

To address the research questions of this study, a quantitative method with several analytic approaches was adopted. Utilizing SPSS 26, we first examined the data before conducting data analysis to ensure the assumptions of multivariate analysis of variance (MANOVA) were met. Specifically, we checked multivariate normality, homogeneity of variance, outliers, and multicollinearity since multiple outcome variables were involved. Examinations of skewness and kurtosis (univariate and multivariate) were conducted for each engagement indicator, perceived gain, and satisfaction score. Analysis indicated no skewness or kurtosis appeared as skewness or kurtosis ranging from -3 to 3 (Kline, 2005). For homogeneity of variance, significance for Box's M Test is determined at $\alpha = 0.001$ because this test is considered highly sensitive. Following Tabachnick and Fidell's suggestion (2013), we checked multicollinearity, and results indicated that neither of the two dependent variables of engagement indicators and perceived gains were correlated to each other above $r = 0.90$. The bivariate correlation coefficients ranged from 0.125 to 0.552 among 10 engagement indicators and ranged from 0.414 to 0.739 among 10 perceived gains. Therefore, there is no evidence that multicollinearity existed between the set of variables of engagement, perceived gains, and satisfaction.

Second, we performed the General Linear Model (GLM) with two multivariate analyses of variance (MANOVAs) to examine the mean differences in engagement indicators and perceived gains between UGR participants and UGR non-participants since multiple composite scores of engagement indicators and perceived gains were examined (Stevens, 2002). The Bonferroni correction was applied to set the significance cut-off for alpha (α), in each case, at 0.005 (0.05/10) since there were 10 dependent variables (10 engagement indicators and 10 perceived gains). In addition, one univariate analysis of variance was conducted to examine the mean difference in overall satisfaction between UGR participants and UGR non-participants. Two conditions that emerged from NSSE data require weighting that must be considered when conducting secondary analysis. One condition is when the proportion of respondents within a particular demographic variable (e.g., gender, full-time/part-time, or adult students) differs substantially from their population percentages. The second condition involves when students within a subgroup differ substantially in the variables of interest (e.g., full-time and part-time students may show different patterns of engagement and participation). Therefore, two sets of weight variables were pre-computed by NSSE for first-year and senior students, respectively, using gender and enrollment status information taken from submitted population files and were included in the data set released to the institution. In this study, weights for gender and full-time/part-time status for senior students were used for calculating means and standard deviations of engagement indicators, perceived gains, and overall satisfaction. The GLM over other procedures allowed the inclusion of sample weights when calculating means and standard deviations of the targeted variables and therefore was employed for the calculation (Chen et al., 2009; NSSE, n.d.).

Lastly, due to the categorical nature of persistence or graduation status ("persisted or graduated" versus "not persisted nor graduated"), we conducted the chi-squared test and logistics regression to address the fourth research question, "How does participation in UGR relate to persistence or graduation status controlling for gender, racial and ethnic minority, first-generation, and low-income status?" The chi-squared test can be used for testing dependence or homogeneity (Franke et al., 2012) and in this study was used to test the proportional differences between students who did and did not participate in UGR based on ethnic minority, first-generation, and low-income status. Hierarchical logistic regression was performed to test for the association of predictive variables with "persisted or graduated" status by adding them as a block to the model one at a time. We included the UGR participation status as one block of the variables, in addition to gender, race and ethnicity, first generation status, and low-income status as one block of control variables. These two blocks of variables were entered into the predictive equation in a hierarchical order to examine which variables significantly predict the outcome variable of persistence or graduation status with an additional block of variables introduced. For the chi-squared test and logistic regression, the alpha level for statistical significance was set at 0.05.

Limitations

We acknowledge the limitations of the study. First, due to the lack of availability of institutional data from other similar campuses, the study focuses on the examination of UGR on student outcomes in one teaching-focused, minority-serving institution. Institutional collaboration for cross-institutional comparisons of student engagement in UGR would help illuminate the reproducibility of the results. Second, the small sample size of UGR participants (13% of the survey-takers) could lead to bias in the results, which means there are not large enough numbers of each racial and ethnic group to allow for the examination of individual racial and ethnic groups. Future examination of the participation patterns of each individual racial and ethnic group by including more participants from each group or merging multiple years of NSSE data will extend current findings. Third, the study relies on self-reported measures of UGR, engagement, perceived gains, and overall satisfaction. Although NSSE relies on self-reported data, we do see a difference between UGR participants and non-participants in terms of persistence and graduation, suggesting the self-reported data is valid and reliable. Validated measures of students' actual participation were not available but would clearly add to the reliability of this study. Future studies may include data from other sources and/or collect more qualitative data to triangulate with quantitative measures (McNair & Finley, 2013). Fourth, although the data of this study were collected in participants' senior year, the participation of UGR did not necessarily happen only in the senior year. However, this study provides an informative snapshot of student experience with UGR *by* senior year.

Results

We organized the results into three sections. Section I presents the results of engagement by UGR participation. Section II follows with results of perceived gains and overall satisfaction by UGR participation. Section III presents persistence or graduation results by disaggregating and comparing the results by UGR participation and minority status, first-generation status, and low-income status, respectively. This section also includes the logistic regression results of persistence or graduation status on UGR participation, controlling for gender, race and ethnicity, first-generation status, and low-income status.

I. Engagement by UGR Participation

In terms of engagement, there was a significant multivariate effect for engagement indicators between UGR participants and UGR non-participants, $F(10, 1161) = 12.30$, $p < 0.001$. UGR participants had significantly higher mean scores on all of the engagement indicators than their UGR non-participants, $ps < 0.005$ (see Table 1 and Figure 1).

Table 1. Means and standard deviations of engagement indicators by UGR participation status

Engagement	No UGR		UGR			
	M^a	*SD*	M^a	*SD*	*F*	*p*
Higher-Order Learning	43.87	13.20	47.26	10.85	9.78	0.002*
Reflective and Integrative Learning	40.53	12.18	45.97	11.21	28.93	0.001**
Learning Strategies	42.62	13.85	46.43	11.84	11.10	0.001**
Quantitative Reasoning	28.12	16.03	36.10	16.02	35.08	0.001**
Collaborative Learning	30.71	14.89	37.03	13.98	25.95	0.001**
Discussions with Diverse Others	43.86	16.44	48.64	14.23	12.42	0.001**
Student-Faculty Interaction	20.01	15.18	33.44	16.86	107.32	0.001**
Effective Teaching Practices	42.11	14.54	45.86	12.08	9.86	0.002*
Quality of Interactions	42.88	13.28	46.60	11.07	11.64	0.001**
Supportive Environment	31.70	14.78	37.25	14.62	20.07	0.001**

a. Weighted Least Squares Regression - Weighted by Gender, FT/PT weight for FY, SR within the institution. * $p < 0.005$ (alpha was set at 0.005, which is 0.05 divided by the number of ANOVAs conducted. It equals to the number of dependent variables, 10 in this case), ** $p < 0.001$.

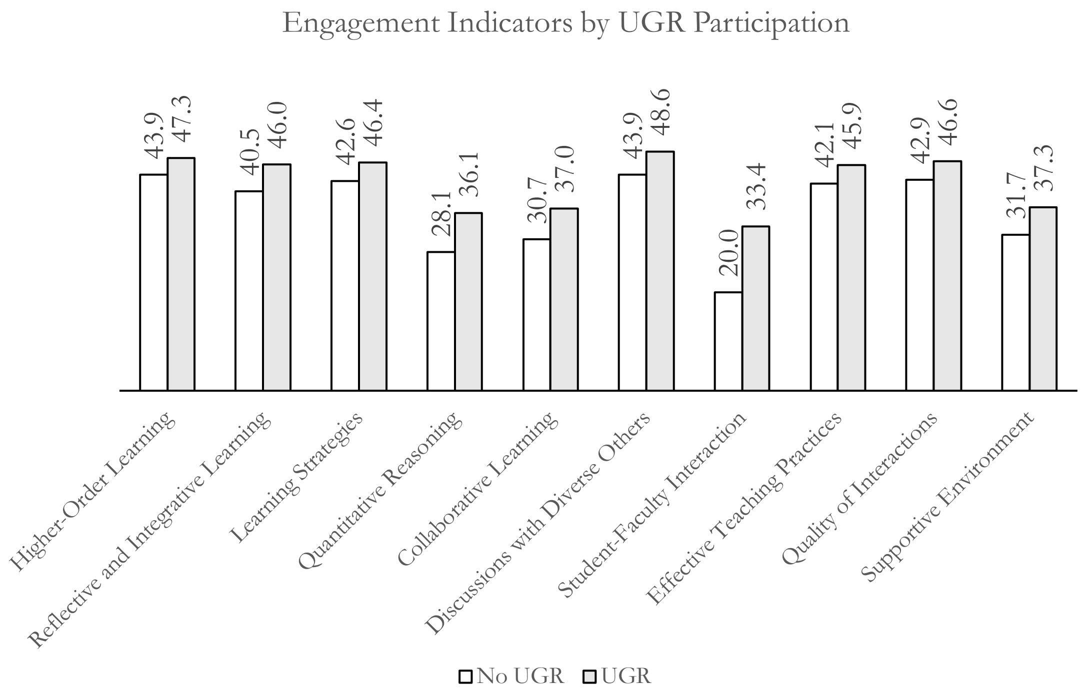

Figure 1. Engagement indicators by UGR participation. Average response scores to each question of the NSSE related to engagement is shown.

II. Perceived Gains and Overall Satisfaction by UGR Participation

Regarding perceived gains, there was a significant multivariate effect for perceived gains between UGR participants and UGR non-participants, $F(10, 1322) = 4.64$, $p < 0.001$. UGR participants reported significantly higher scores on almost all of the perceived gains than their UGR non-participants, *ps* < 0.001, except "*Developing or clarifying a personal code of values and ethics*" (see Table 2 and Figure 2). Similarly, there was a significant multivariate effect for perceived gains between UGR participants and UGR non-participants, $F(1, 1394) = 12.33$, $p < 0.001$. UGR participants reported a significantly higher level of overall satisfaction than their UGR non-participants, $p < 0.001$ (see Table 2 and Figure 2).

Table 2. Means and standard deviations of perceived gains and overall satisfaction by UGR participation status

Perceived gains	No UGR		UGR			
	M[a]	*SD*	*M*[a]	*SD*	*F*	*p*
Writing clearly and effectively	40.69	17.73	46.25	15.96	15.71	0.001**
Speaking clearly and effectively	37.52	18.96	43.56	16.87	16.25	0.001**
Thinking critically and analytically	45.85	15.96	52.05	11.58	25.10	0.001**
Analyzing numerical and statistical information	35.37	19.97	44.72	16.88	35.53	0.001**
Acquiring job- or work-related knowledge and skills	39.31	19.67	44.63	17.63	11.72	0.001**
Working effectively with others	40.06	18.09	45.06	16.39	12.22	0.001**
Developing or clarifying a personal code of values and ethics	37.47	20.11	41.53	19.15	6.44	0.011

Understanding people of other backgrounds	38.87	18.98	43.93	17.12	11.35	0.001**
Solving complex real-world problems	37.43	19.30	44.38	16.88	20.88	0.001**
Being an informed and active citizen	34.60	20.21	40.59	18.20	14.06	0.001**
Overall satisfaction	47.97	13.93	51.86	11.20	12.35	0.001**

a. Weighted Least Squares Regression - Weighted by Gender, FT/PT weight for FY, SR within the institution. ** $p < 0.001$ (alpha was set at 0.005, which is 0.05 divided by the number of ANOVAs conducted. It equals to the number of dependent variables, 10 in this case).

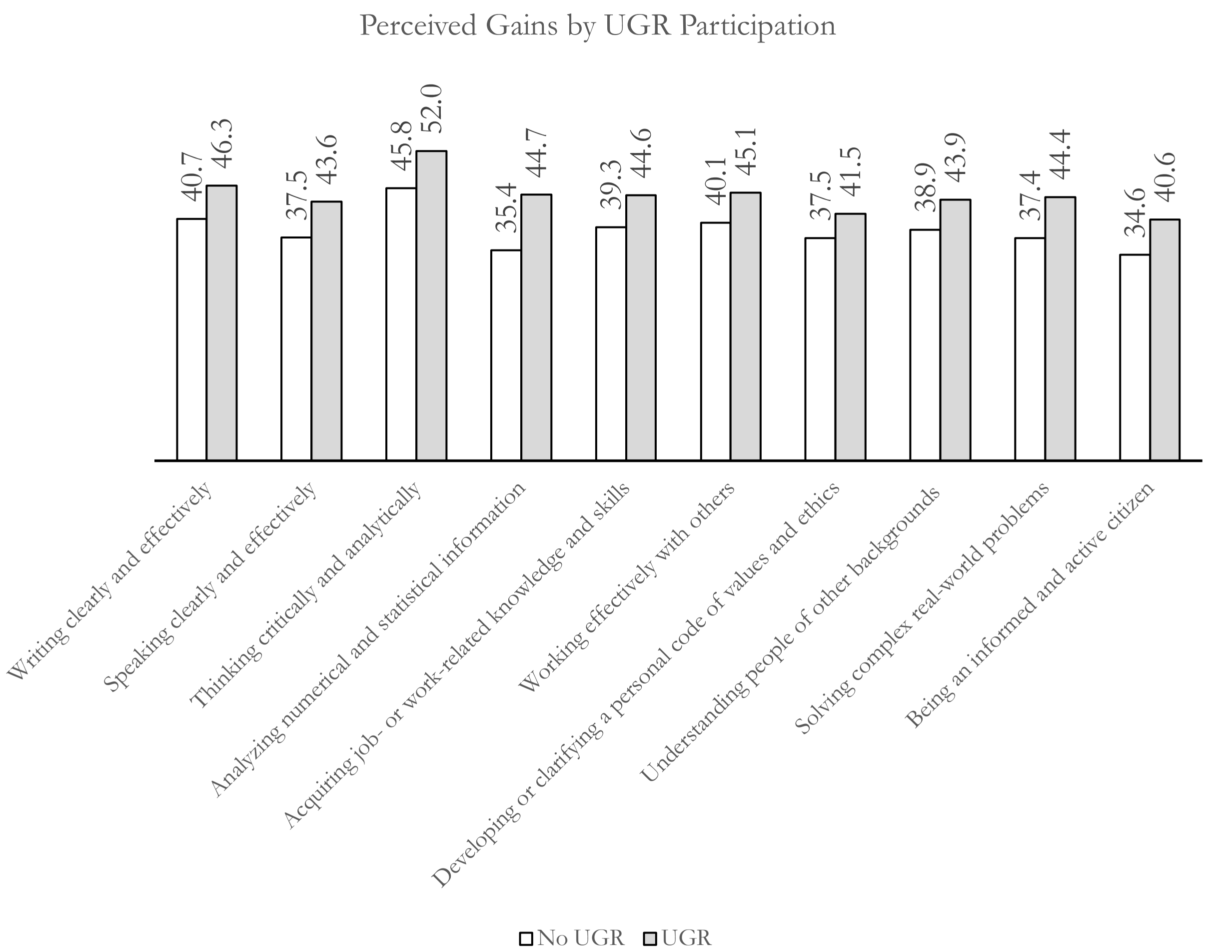

Figure 2. Perceived gains by UGR participation. Average response scores to each question of the NSSE related to perceived gains is shown.

III. Persistence and Graduation Outcomes by UGR Participation

Table 3 presents whether a student persisted (re-enrolled or graduated) (see Table 3 Column 4) and whether they graduated by summer after reaching senior status (see Table 3 Column 5) by UGR participation and race and ethnicity, first-generation status, and low-income status. Overall, there is a significantly larger proportion of UGR participants (95.4%) still enrolled or graduated than their peer counterparts of UGR non-participants (88.3%). The trends hold true when disaggregating the results by minority, first-generation, and low-income status. A significantly larger proportion of UGR-participating students graduated compared to their non-participating peers, regardless of first-generation status or low-income status. Although ethnic minority UGR participants persisted at a higher rate (91.8%) than UGR non-participants (87.9%) (see Table 3, Column 4), the proportional difference was not significant.

Table 3. Persistence or graduation by UGR participation, race/ethnicity, first-generation, and low-income status

	UGR Participation	Total	Persisted (Re-enrolled or Graduated)	Graduated
Overall	No	1,278	1129 (88.3%)	441 (34.5%)
	Yes	194	185 (95.4%)	117 (60.3%)
	Total	1,472	1,314	558
	Statistical test		$\chi^2(1) = 8.66, p < 0.01$	$\chi^2(1) = 47.64, p < 0.01$
Minority	No	569	500 (87.9%)	196 (34.4%)
	Yes	97	89 (91.8%)	48 (49.5%)
	Total	666	589	244
	Statistical test		$\chi^2(1) = 1.22, p > 0.05$	$\chi^2(1) = 8.07, p < 0.01$
Non-Minority	No	672	596 (88.7%)	238 (35.4%)
	Yes	92	91 (98.9%)	65 (70.7%)
	Total	764	687	303
	Statistical test		$\chi^2(1) = 9.33, p < 0.01$	$\chi^2(1) = 41.98, p < 0.01$
First-Generation	No	825	729 (88.4%)	293 (35.5%)
	Yes	129	122 (94.6%)	76 (58.9%)
	Total	954	851	369
	Statistical test		$\chi^2(1) = 4.47, p < 0.05$	$\chi^2(1) = 25.75, p < 0.01$
Non-First-Generation	No	453	400 (88.3%)	148 (32.7%)
	Yes	65	63 (96.9%)	41 (63.1%)
	Total	518	463	189
	Statistical test		$\chi^2(1) = 4.45, p < 0.05$	$\chi^2(1) = 22.68, p < 0.01$
Low-Income	No	652	600 (92.0%)	257 (39.4%)
	Yes	124	118 (95.2%)	75 (60.5%)
	Total	776	718	332
	Statistical test		$\chi^2(1) = 1.48, p > 0.05$	$\chi^2(1) = 18.89, p < 0.01$
Non-Low-Income	No	626	529 (84.5%)	184 (29.4%)
	Yes	70	67 (95.7%)	42 (60.0%)
	Total	696	596	226
	Statistical test		$\chi^2(1) = 6.42, p < 0.05$	$\chi^2(1) = 26.90, p < 0.01$

Regarding institutional outcomes, overall, we observed an increase in persistence for UGR participants vs. UGR non-participants. For seniors who participated in UGR, a significantly larger proportion graduated by summer after reaching senior status or re-enrolled in the next fall (95.4%) compared to their peers who did not participate in UGR (88.3%), $\chi^2(1) = 8.66$, $p < 0.01$, phi = 0.07. The overall persistence boost is 7.1% for UGR participants against UGR non-participants (see Table 3 Column 4). The trends hold true for all subgroups examined, including minority, first-generation, and low-income students. A significantly higher proportion of students who participated in UGR persisted or graduated than their UGR non-participants, regardless of race and ethnicity, first-generation status, and low-income status (see Table 3, Column 4 and Figure 3).

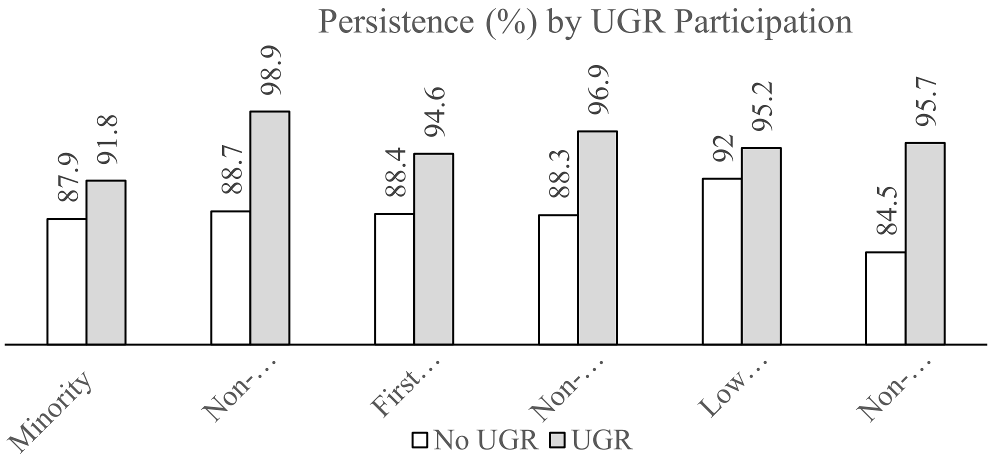

Figure 3. Persistence Outcomes by UGR Participation.

Similarly, overall, we observed higher rates of graduation for UGR participants compared to non-participants. For seniors who participated in UGRs, a significantly larger proportion graduated by summer after reaching senior status and completing the NSSE survey (60.3%) compared to their peers who did not participate in UGR (34.5%), $\chi^2(1) = 47.64$, $p < 0.01$, phi = 0.18 (see Table 3 Column 5). This was true across all subgroups examined, regardless of minority, first-generation, or low-income status (see Figure 4).

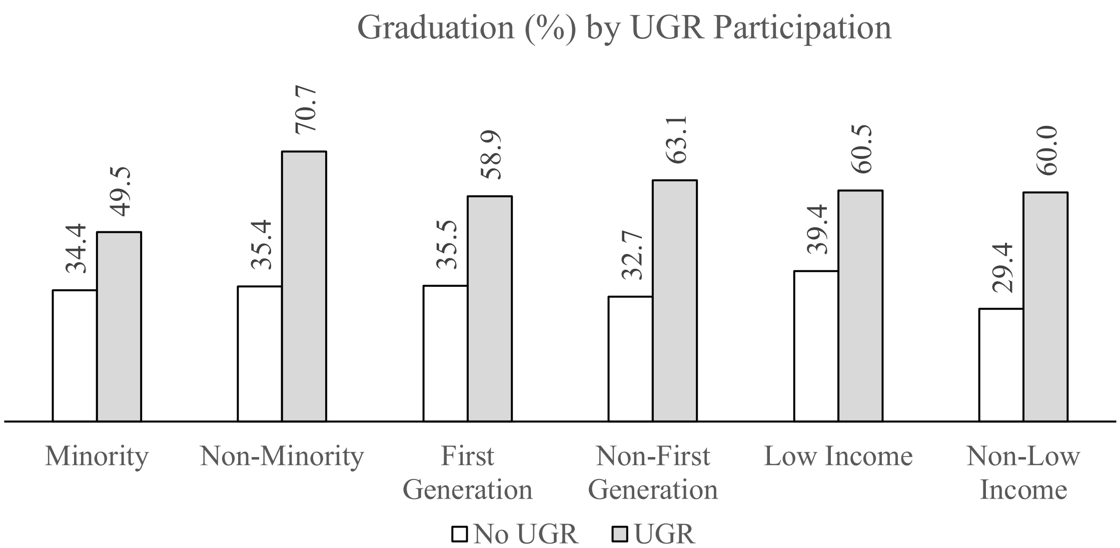

Figure 4. Graduation Outcomes by UGR Participation.

A logistic regression was conducted for persistence (fall to fall re-enrollment or graduation by summer after NSSE administration) on UGR participation controlling for gender, race and ethnicity, first-generation status, and low-income status. After controlling for other variables, the results indicated that UGR participation was a significant predictor of persistence, Wald $F(1) = 6.93$, $p < 0.01$ (see Table 4). This indicates that there is a positive relationship between UGR participation and persistence. If a student participated in UGR, the odds of this student persisting would increase by 155 percent. First-generation status was also a significant predictor of persistence status, Wald $F(1) = 16.11$, $p < 0.01$ (see Table 4). Being a first-generation student, the odds of that student being retained or graduated would increase by 105 percent. Gender, race and ethnicity, and low-income status were not significant predictors of retention or graduation status, Wald $F(1) = 2.77$, 1.788, and 0.186, $ps > 0.05$, respectively (see Table 4).

Table 4. Regression results of retention or graduation status on UGR participation (controlling for other variables).

	B†	SE‡	Wald§	df**	*p*††	Exp(B) ‡‡
Gender	-0.336	0.202	2.770	1	0.096	0.715
Ethnic Minority	-0.232	0.173	1.788	1	0.181	0.793
First-Generation Status	0.718	0.179	**16.11**§§	1	**0.001**	**2.050**
Low-Income Status	-0.079	0.183	0.186	1	0.666	0.924
UGR	0.935	0.355	**6.928**	1	**0.008**	**2.548**
Constant	1.934	0.183	111.272	1	0.001	6.920

* Hierarchical linear regression is a statistical technique that tests for the influence variables by adding them to the model one at a time.
† B lists the partial logistic regression coefficients for each independent variable.
‡ S.E. or standard error measures the accuracy with which a sample represents a population.
§ Wald is a way of testing the significance of independent variables in a statistical model.
** df or degree of freedom is the number of values in the study that are free to vary.
†† *p* is an estimate of the probability that the result occurred by statistical accident. A low level of *p* indicates a high level of statistical significance.
‡‡ Exp(B) list the odds ratios, which are used to assess the isolated impact of each independent variable.
§§ Bold indicates statistically significant results.

Discussion

The Relationship between UGR Participation and Engagement

UGR participants reported significantly higher scores on all of the engagement indicators compared to their UGR non-participants. Their multiple and positive experiences with the four NSSE engagement themes (i.e., being academically challenged, learning with peers, working with faculty, and having a supportive environment to thrive) were reflected in their responses. Notably, students reported higher scores of student-faculty interactions, quantitative reasoning, and collaborative learning experiences (13.4, 8.0, and 6.3 higher for UGR participants compared to non-participants, respectively, see Table 1 and Figure 1). This is important because these represent relationship-building and skills-development that can contribute to persistence, completion, and improved performance in graduate school or the workforce. UGR opportunities promote teamwork where students can learn from one another and employ collaboration and communication skills in authentic situations that they wouldn't otherwise practice in a classroom, and this is reflected in the 6.3 increase of reported experience with collaborative learning. Students must contribute collectively, as well as be held accountable to accomplish tasks independently when engaged in research teams (Madan & Teitge, 2013). Whether students choose to go on to graduate school or join the workforce upon graduation, knowing how to work in teams and communicate with diverse colleagues are highly valued skills (Baird & Parayitam, 2019).

In addition, these results confirm that UGR requires participants to use higher order thinking and metacognitive skills (UGR participants reported 3.4 higher gains in higher order learning and 5.5 gains in reflective and integrative learning, respectively, compared to non-participants). In conducting research, students have to collect, apply, analyze, and synthesize, as well as interpret and evaluate information that is being studied. The direct impact of UGR on metacognition has been reported by Dahlberg et al. (2019) and Kortz and van der Hoeven Kraft (2016), but this NSSE data from seniors implies that the gains are recognized by the student participants and persist to the senior year, even if the research happened previously. Too often institutions of higher education are criticized for not facilitating the development of higher order thinking skills among students (Arum & Roksa, 2011), but UGR may be a way to ensure students hone these skills.

Lastly, the 13.4 gain in UGR participants reports of student-faculty interaction compared to non-participants is worth celebrating. One of the most important factors in students' success in college is their interactions with faculty (Anaya & Cole, 2001; Campbell & Campbell, 1997; Chickering & Gamson, 1987; DeAngelo et al., 2016; Eagan et al., 2013). Students who participate in UGR have *regular* and *meaningful* interactions with faculty (Taraban & Logue, 2012). Students who work with a faculty mentor achieve higher academic performance, gain networking opportunities and feel welcomed into the discipline, and develop confidence (DeAngelo et al., 2016). These interactions are especially important for underrepresented minority students who may have an increased sensitivity to mentoring relationships (Jones et al., 2010; Lopatto, 2004). That UGR facilitates such increased perception of these interactions at a teaching institution, where research is likely occurring in non-traditional ways, is note-worthy.

The Relationship between UGR Participation and Perceived Gains and Overall Satisfaction

UGR participants reported significantly higher scores on almost all of the perceived gains compared to UGR non-participants and had significantly higher levels of overall satisfaction (the only gain that was not significantly increased was "developing or clarifying a personal code of values and ethics", see Table 2). Notably, UGR participants had higher gains compared to their non-participant peers in analyzing numerical and statistical information (9.3 point gain), solving complex real-world problems (7 point gain), thinking critically and analytically (6.2 point gain), and being an informed and active citizen (6 point gain) (see Table 2). In today's day and age, we think all efforts that increase these metrics in students should be employed.

Students who participated in UGR positively evaluated their educational experiences, said they would go to the same institution if they had to start over, and reported positive relationships with peers, advisors, faculty, staff, and students (data not shown). Participating in UGR promotes perceived gains in personal (e.g., understanding people of different backgrounds), practical (e.g., working effectively with others), and general education competency (e.g., solving complex real-world problems) areas, as well as higher satisfaction in their educational experience. These types of gains had been documented in both an apprentice-type research experience and a CURE (Kinner & Lord, 2018; Williams et al., 2016), though both these previous reports focused exclusively on self-reported gains immediately after a single STEM course or summer research experience at a research university. We demonstrate that these gains occur at teaching institutions and potentially persist far beyond the actual UGR experience.

The Relationship between UGR and Persistence and Graduation Disaggregated by Race and Ethnicity, First-generation Status, and Low-income Status

Participating in UGR positively impacts persistence (re-enrollment or graduation by the fall following NSSE administration) or graduation. In this study, a significantly higher proportion of students who participated in UGR graduated within one year of becoming a senior (60.3%) than non-participants (35.4%). This trend was true regardless of minority, first-generation, or low-income status. These findings corroborate studies noted earlier in the paper; working on novel research with a faculty member positively impacts student retention and graduation (Eagan et al., 2013; Lopatto, 2010; Seymour et al., 2004).

It is worth noting that we did observe a significant racial equity gap in the impact of UGR when it comes to persistence and graduation. While an admirable 91.8% of UGR participating racial and ethnic minority students persisted, the percent of non-minority UGR participants that persisted was 98.9% (Table 3 Column 4, and Figure 3). Even more startling is the fact that only 49.5% of minority UGR-participants in our data set graduated by summer after reaching their senior status, compared to 70.7% non-minority UGR-participants (Table 3 Column 5, and Figure 4). The "boost" in persistence and graduation rates for non-minority students is significantly higher than it is for minority students (see Figure 5). While we cannot eliminate the possibility that there were compounding factors that could impact this data, such as unique disciplinary differences, we suspect the data is straightforward: minority students face additional obstacles that opportunities like UGR are not sufficient in eliminating. Interestingly, there was almost no gap in graduation rates between low-income and non-low-income UGR participants (60.5% compared to 60.0% respectively, see Figure 4), so the racial equity gap may not be due to intersecting economic barriers. Similarly, there was only a small difference in the percent of UGR-participating first-generation students that graduated within a year of starting their senior year (58.1%) compared to non-first-generation students (63.1%). As teaching institutions develop additional UGR opportunities, it is critical that faculty and administrators evaluate the literature on how best to support, retain, and graduate minority students.

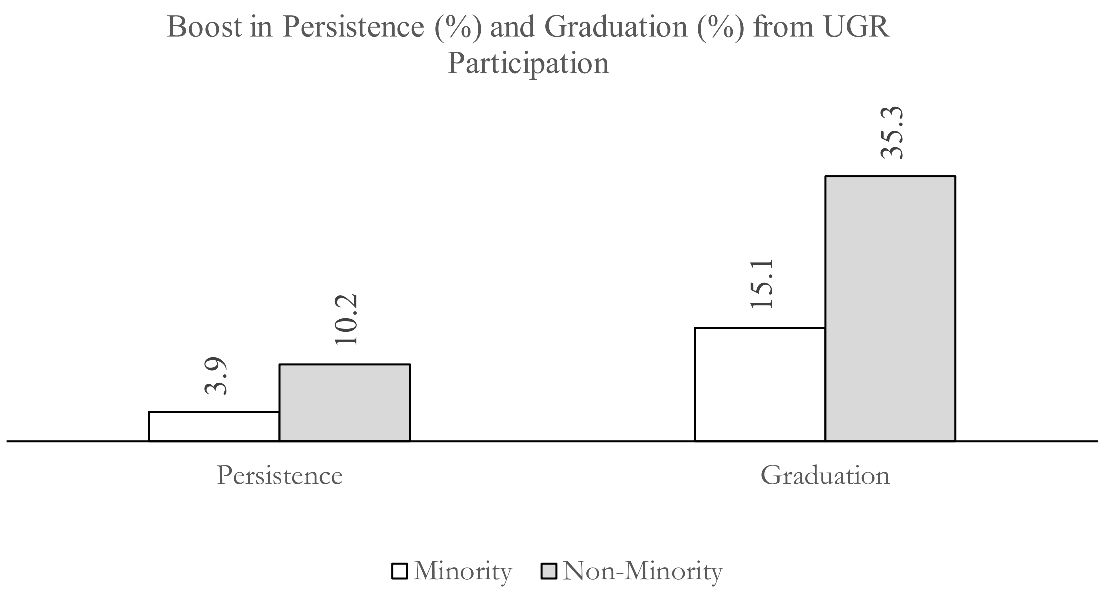

Figure 5. Persistence and Graduation Boost by UGR Participation for Minority and Non-Minority.

Overall Impact of UGR

UGR is positively associated with higher perceived gains, satisfaction, persistence, and graduation. We recognize that we cannot conclude that UGR causes improved outcomes, as students that are more likely to be engaged or satisfied or likely to persist/graduate could be more likely to participate in UGR. Indeed, Webber and colleagues (2013) reported that some students (i.e., students in STEM, students participating in Greek life, students attending full-time, and students with higher GPAs) were somewhat more likely to participate in UGR. However, Fechheimer and colleagues (2011) have shown that participation in research-based classes at a research university led to significant increases in academic success outcomes, even when they controlled for SAT scores - a measure of academic ability prior to the UGR experience. This contradicts an explanation of more engaged or capable students selecting UGR and thus performing better. Although we cannot claim causality, there is clearly a positive relationship between UGR and academic success/completion, and this has implications at different levels. As stated earlier, there is a dearth of literature on why students *do not* participate in research. Lack of time (Stout, 2018), working a significant number of hours outside of school (Falcon, 2015; RTI International, 2019), and challenges balancing between time and research are cited in the literature. Because the gains for students are so large and so consistent, we would argue that teaching colleges continue to find ways to involve more students in UGR or reduce/eliminate barriers to these activities (several suggested mechanisms are discussed below). Still, the impacts of these activities at this institution were higher for non-minority students, and thus additional interventions to support these students must be considered. Future studies should increase the sample size so individual racial/ethnic groups can be examined. In addition, qualitative interviewing/focus groups of minority students to understand why gains from UGR participation are not equal in terms of persistence and graduation would be useful.

Approaches Teaching-Centered Colleges Can Take to Enhance UGR

One of the easiest ways for teaching-centered colleges to curate additional UGR opportunities is to embrace existing CUREs that are intended to be reproduced and in fact leverage crowd-sourced data from multiple institutions. These are most commonly in the sciences and are aimed at introductory-level courses, making them accessible even at community colleges. For example, the Howard Hughes Medical Institute's Science Education Alliance (SEA) has both a PHAGES program and subsequent GENES program to characterize novel bacteriophages and is open to all 2-year and 4-year institutions (https://www.hhmi.org/science-education/programs/science-education-alliance). Yale University created the Small World Initiative, www.smallworldinitiative.org, which boasts an international network to curate the world's next highly-needed antibiotics. These programs offer resources and support for faculty joining these projects. While limited, some entities are trying to curate existing CURE projects, such as CureNet (https://serc.carleton.edu/curenet/index.html), which can be a resource for teaching institution faculty, as well.

There are promising opportunities for the humanities and social sciences to embed research in their courses, as well. For example, for those in psychology, the Collaborative Replications and Education Project (https://osf.io/wfc6u/) strives to find groups, such as classes, to reproduce highly-cited studies, and the Emerging Adulthood Measured at Multiple Institutions project (https://osf.io/te54b/) seeks new collaborators to help investigate attitudes, behaviors, and beliefs related to emerging adulthood. General faculty can visit Zooniverse.org to find 25 crowd-sourced data projects that their students can engage with and discuss, from transcribing supreme court justice's hand-written notes or tracking the life histories of historical criminals to classifying baby speech sounds (Zooniverse.org). The Council on Undergraduate Research (www.cur.org), while requiring membership, has archived highlights of collaborative undergraduate research projects in broad disciplines from the arts and humanities to social sciences to engineering. Others have published about course-based methods in community-based surveys for social science courses (Crowe & Boe, 2019), as well as the use of existing databases or community-generated data for research in introductory statistics courses (Le, 2020). At our Institution, faculty in Psychology leverage methodology courses to implement short but authentic research projects among student groups.

Inspiration can be found nationally and locally for increasing research opportunities. Community colleges can gain inspiration from the Community College Undergraduate Research Initiative (https://www.ccuri.org/), which has established a large network across the country to develop opportunities for research. Research experiences range from field work and laboratory investigations to interview transcription, recording and data entry, or basic analyses requiring what would be expected in a collegiate statistics course. Even the use of student workers as research assistants can be a modern modification to the traditional apprentice model. In all disciplines, there is also the opportunity for local collaboration to undergird novel experiences for students: community colleges can partner with local research institutes, and professional school faculty (such as those in Education or Nursing) can collaborate with local organizations (schools, hospitals, non-profits, etc.) to engage in action research.

Administrative support is also critical to the initiation and success of undergraduate research at teaching-centered colleges. At our institution, the Provost provided seed-funding awards for faculty scholarship that involved students and provided compensation for several faculty to engage in a summer institute to construct/revamp courses to embed scholarly research. For example, this enabled a history faculty member to develop a collaboration with a local fire department to create a multi-semester project for students to archive and research unique materials, untouched for fifty years, from firehouse storage. Centralized support for grant writing and submission, library resources with sufficient staff and adequate access to materials, travel support for sharing work, and recognition and compensation for faculty mentoring of undergraduate researchers are also ways administration can facilitate growth in UGR at teaching-centered institutions and community colleges (Marwick, 2012). While curriculum is a product of the faculty, there are certainly ways in which the administration can collaborate with faculty on curricular requirements for UGR and support faculty in course redesign. Policies can be generated that allow faculty to leverage independent study projects with students into future course releases. Studies have shown faculty are willing and eager to engage with students in activities like UGR, but in the end, administrators are key in ensuring that the *benefits to faculty* reflect the subsequent benefits to students and facilitate their choices to make greater UGR opportunities a reality (Eagan et al, 2011).

Conclusion

In this study, we sought to examine whether there were differences in seniors' level of engagement, perceived gains, and overall satisfaction relative to their participation in UGR in a regional, comprehensive institution. Additionally, the extent to which participation in UGR impacted persistence and graduation after reaching the senior year was explored. The findings yielded positive results in all outcomes, demonstrating the importance of UGR at teaching-centered institutions.

Undergraduate research can be implemented and leveraged at teaching-focused colleges to enhance the student experience, as well as assist in critical persistence and graduation imperatives. Teaching colleges can and should embrace a variety of UGR methods, from CUREs to modified credit-bearing apprenticeship models with flexibility for diverse student needs. Faculty across disciplines could be encouraged to embed authentic inquiry experiences in their classes to increase their students' knowledge and skills in research. While selected disciplines in teaching colleges, for example education and nursing, might have a more difficult time embedding research into their courses due to the high number of required clinical hours in the field and other licensure requirements, targeted professional development and mentoring could assist faculty in embedding meaningful research opportunities for students in their courses that would enhance the overall learning experience. While historically UGR has been more prominent at research institutions, many types of UGR can be adapted to teaching institutions, including CUREs, research internships for credit, and modified apprentice models where small numbers of students work directly with a faculty member on a study for credit. Colleges should find and fund mechanisms to help train faculty to build these kinds of courses and programs and support these programs with space and administrative support. The return on investment is clear: enhanced engagement, gains, satisfaction, persistence, and graduation, all of which will lead to more adaptive, qualified, and fulfilled alumni.

Appendix

	Question in NSSE	**Example Items**
I. Student Engagement Indicator		
Higher-Order Learning (HO)	*During the current school year, how much has your coursework emphasized the following* (Very much, quite a bit, some, very little)	Applying facts, theories, or methods to practical problems or new situations
		Analyzing an idea, experience, or line of reasoning in depth by examining its parts
Learning Strategies (LS)	*During the current school year, how often have you* (Very often, often, sometimes, never)	Identified key information from reading assignments
		Summarized what you learned in class or from course materials
Quantitative Reasoning (QR)	*During the current school year, how often have you* (Very often, often, sometimes, never)	Reached conclusions based on your own analysis of numerical information (numbers, graphs, statistics, etc.)
		Used numerical information to examine a real-world problem or issue (unemployment, climate change, public health, etc.)
Collaborative Learning (CL)	*During the current school year, how often have you* (Very often, often, sometimes, never)	Asked another student to help you understand course material
		Prepared for exams by discussing or working through course material with other students
Discussions with Diverse Others (DD)	*During the current school year, how often have you had discussions with people from the following groups* (Very often, often, sometimes, never)	People from a race or ethnicity other than your own
		People from an economic background other than your own
Student-Faculty Interaction (SF)	*During the current school year, how often have you* (Very often, often, sometimes, never)	Talked about career plans with a faculty member
		Worked with a faculty member on activities other than coursework (committees, student groups, etc.)
Effective Teaching Practices (ET)	*During the current school year, to what extent have your instructors done the following* (Very much, quite a bit, some, very little)	Clearly explained course goals and requirements
		Used examples or illustrations to explain difficult points
Quality of Interactions (QI)	*Indicate the quality of your interactions with the following people at your institution* (1: Poor to 7: excellent)	Students
		Academic advisors
		Faculty
Supportive Environment (SE)	*How much does your institution emphasize the following* (Very much, quite a bit, some, very little)	Providing support to help students succeed academically
		Using learning support services (tutoring services, writing center, etc.)
II. Perceived Gains (PG)		
	How much has your experiences at this institution contributed to your knowledge, skills, and personal development in the following areas? (Very much, quite a bit, some, very little)	Writing clearly and effectively
		Acquiring job- or work-related knowledge and skills
III. Overall Satisfaction (OS)		

Evaluation (EV)	*How would you evaluate your entire educational experience at this institution?*	Excellent, good, fair, and poor
Whether go to the same institution (SI)	*If you could start over again, would you go to the same institution you are now attending?*	Definitely yes, probably yes, probably no, definitely no

References

Anaya, G., & Cole, D. G. (2001). Latina/o student achievement: Exploring the influence of student-faculty interactions on college grades. *Journal of College Student Development*, *42*(1), 3–14. Retrieved from https://www.researchgate.net/publication/285632628_Latinao_student_achievement_Exploring_the_influence_of_student-faculty_interactions_on_college_grades

Arum, R., & Roksa, J. (2011). *Academically adrift: Limited learning on college campuses*. Chicago, IL: University of Chicago Press.

Auchincloss, L. C., Laursen, S. L., Branchaw, J. L., Eagan, K., Graham, M., Hanauer, D. I., … Dolan, E. L. (2014). Assessment of course-based undergraduate research experiences: A meeting report. *CBE-Life Sciences Education*, *13*(1), 29–40. https://doi.org/10.1187/cbe.14-01-0004

Baird, A. M., & Parayitam, S. (2019). Employers' ratings of importance of skills and competencies college graduates need to get hired: Evidence from the New England region of USA. *Education + Training*, *61*(5), 622–634. https://doi.org/10.1108/ET-12-2018-0250

Bangera, G., & Brownell, S. E. (2014). Course-based undergraduate research experiences can make scientific research more inclusive. *CBE-Life Sciences Education*, *13*(4), 602–606. https://doi.org/10.1187/cbe.14-06-0099

Brandt, L. S. E., & Hayes, J. L. (2012). Broader impacts of undergraduate research at a community college: Opening doors to new ideas. *Council on Undergraduate Research Quarterly*, *33*(1), 17–21. Retrieved from https://www.cur.org/assets/1/7/331Fall12Brandt.pdf

Campbell, T. A., & Campbell, D. E. (1997). Faculty/student mentor program: Effects on academic performance and retention. *Research in Higher Education*, *38*(6), 727–742. https://doi.org/10.1023/A:1024911904627

Carpi, A., Ronan, D. M., Falconer, H. M., & Lents, N. H. (2017). Cultivating minority scientists: Undergraduate research increases self-efficacy and career ambitions for underrepresented students in STEM. *Journal of Research in Science Teaching*, *54*(2), 169–194. https://doi.org/10.1002/tea.21341

Cejda, B. D., & Hensel, N. H. (2009). *Undergraduate research at community colleges*. Washington, DC: Council on Undergraduate Research.

Center, N. R. (2017). Two-year contributions to four-year completions-2017. National Student Clearinghouse Research Center. Retrieved from https://nscresearchcenter.org/snapshotreport-twoyearcontributionfouryearcompletions26/

Chen, P. S. D., Gonyea, R. M., Sarraf, S. A., BrckaLorenz, A., Korkmaz, A., Lambert, A. D., … Williams, J. M. (2009). Analyzing and interpreting NSSE data. *New Directions for Institutional Research*, 141, 35–43. doi: 10.1002/ir.285

Chickering, A. W., & Gamson, Z. F. (1987). *Seven Principles for Good Practice in Undergraduate Education*. AAHE Bulletin. Retrieved from http://eric.ed.gov/?id=ED282491

Crowe, J., & Boe, A. (2019). Integrating undergraduate research into social science curriculum: Benefits and challenges of two models. *Education Sciences, 9*(4), 1–13. doi:10.3390/educsci9040296

Dahlberg, C. L., Wiggins, B. L., Lee, S. R., Leaf, D. S., Lily, L. S., Jordt, H., & Johnson, T. J. (2019). A short, course-based research module provides metacognitive benefits in the form of more sophisticated problem solving. *Journal of Science College Teaching, 48*(4), 22–30. doi: 10.2505/4/jcst19_048_04_22

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., 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

Eagan, M. K., Jr., Sharkness, J., Hurtado, S., Mosqueda, C. M., & Chang, M. J. (2011). Engaging undergraduates in science research: Not just about faculty willingness. *Research in higher education, 52*(2), 151–177. https://doi.org/10.1007/s11162-010-9189-9

Falcon, L. (2015). Breaking down barriers: First-generation college students and college success. *The Learning Assistance Review (TLAR), 17*(2), 7–20. https://files.eric.ed.gov/fulltext/EJ1002281.pdf

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How well do undergraduate research programs promote engagement and success of students? *CBE life sciences education*, *10*(2), 156–163. https://doi.org/10.1187/cbe.10-10-0130

Franke, T. M., Ho, T., & Christie, C. A. (2012). The chi-square test: Often used and more often misinterpreted. *American Journal of Evaluation*, *33*(3), 448–458. https://doi.org/10.1177/1098214011426594

Gardner, J. N., & Veer, G. V. der. (1998). *The senior year experience: Facilitating integration, reflection, closure, and transition*. San Francisco, CA: Jossey-Bass Publishers.

Harrison, M., Dunbar, D., Ratmansky, L., Boyd, K., & Lopatto, D. (2011). Classroom-based science research at the introductory level: Changes in career choices and attitude. *CBE-Life Sciences Education*, *10*(3), 279–286. https://doi.org/10.1187/cbe.10-12-0151

Hathaway, R. S., Nagda, B. (Ratnesh) A., & Gregerman, S. R. (2002). The relationship of undergraduate research participation to graduate and professional education pursuit: An empirical study. *Journal of College Student Development*, *43*(5), 614–631. doi: 10.1353/jhe.2015.0031

Hu, S., Kuh, G. D., & Gayles, J. G. (2007). Engaging undergraduate students in research activities: Are research universities doing a better job? *Innovative Higher Education*, *32*(3), 167–177. https://doi.org/10.1007/s10755-007-9043-y

Hurtado, S., Newman, C. B., Tran, M. C., & Chang, M. J. (2010). Improving the rate of success for underrepresented racial minorities in STEM fields: Insights from a national project. *New Directions for Institutional Research*, *2010*(148), 5–15. https://doi.org/10.1002/ir.357

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

Jordan, T. C., Burnett, S. H., Carson, S., Caruso, S. M., Clase, K., DeJong, R. J., … Hatfull, G. F. (2014). A broadly implementable research course in Phage Discovery and Genomics for first-year undergraduate students. *MBio*, *5*(1), e01051-13. https://doi.org/10.1128/mBio.01051-13

Kinner, D., & Lord, M. (2018). Student-perceived gains in collaborative, course-based undergraduate research experiences in the geosciences. *Journal of College Science Teaching*, *48*(2), 48–58. https://doi.org/10.2307/26616270

Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, NY: Guilford.

Kortz, K. M., & van der Hoeven Kraft, K. J. (2016). Geoscience education research project: Student benefits and effective design of a course-based undergraduate research experience. *Journal of Geoscience Education, 64*, 24-36. https://doi.org/10.5408/15-11.1

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

Le, P. (2020). Authentic messiness: A community-based learning model in an introduction to data, and statistics course. *PRIMUS, 30*(2), 147-159. https://doi.org/10.1080/10511970.2018.1525595

Lopatto, D. (2004). Survey of Undergraduate Research Experiences (SURE): First findings. *Cell Biology Education*, *3*(4), 270–277. https://doi.org/10.1187/cbe.04-07-0045

Lopatto, D. (2010). Undergraduate research as a high-impact student experience. *Peer Review*, *12*(2), 27–30. Retrieved from https://www.aacu.org/publications-research/periodicals/undergraduate-research-high-impact-student-experience

Madan, C., & Teitge, B. (2013). The benefits of undergraduate research: The student's perspective. *The Mentor: An Academic Advising Journal*, *15*. https://doi.org/10.26209/mj1561274

Marwick, J. (2012). Advancing undergraduate research at community colleges. In *Characteristics of excellence in undergraduate research* (pp. 36–37). Washington, DC: Council on Undergraduate Research.

McNair, T. B., & Finley, A. (2013). *Assessing underserved students' engagement in high-impact practices*. Washington, DC: Association of American Colleges and Universities. Retrieved from https://www.aacu.org/assessinghips/report

National Survey of Student Engagement. (n.d.). An explanation of weighting in the NSSE institutional report. Retrieved from https://nsse.indiana.edu/nsse/reports-data/weighting.html

National Survey of Student Engagement. (n.d.). SPSS syntax for common NSSE analyses. Retrieved from https://nsse.indiana.edu/nsse/working-with-nsse-data/syntax/index.html

O'Donnell, K., Botelho, J., Brown, J., González, G. M., & Head, W. (2015). Undergraduate research and its impact on student success for underrepresented students. *New Directions for Higher Education, 169,* 27–38. https://doi.org/10.1002/he.20120

RTI International. (2019). *First-generation college students: Demographic characteristics and postsecondary enrollment*. NAPSA. Retrieved from https://firstgen.naspa.org/files/dmfile/FactSheet-04.pdf

Seymour, E., Hunter, A. B., Laursen, S. L., & DeAntoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education*, *88*(4), 493–534. https://doi.org/10.1002/sce.10131

Shaffer, C. D., Alvarez, C., Bailey, C., Barnard, D., Bhalla, S., Chandrasekaran, C., … Elgin, S. C. R. (2010). The genomics education partnership: Successful integration of research into laboratory classes at a diverse group of undergraduate institutions. *CBE Life Sciences Education*, *9*(1), 55–69. https://doi.org/10.1187/09-11-0087

Stevens, J. (2002). *Applied multivariate statistics for the social sciences*. New York, NY: Lawrence Erlbaum Associates.

Stout, J. (2018). Understanding why many undergraduate students don't participate in research. CRN. Retrieved from https://cra.org/crn/2018/04/understanding-why-most-undergraduate-students-dont-participate-in-research/

Tabachnick, B., & Fidell, L. (2013). *Using multivariate statistics* (6th ed.). New York, NY: Pearson.

Taraban, R., & Logue, E. (2012). Academic factors that affect undergraduate research experiences. *Journal of Educational Psychology*, *104*(2), 499–514. https://doi.org/10.1037/a0026851

Webber, K. L., Laird, T. F. N., & 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

Wei, C. A., & Woodin, T. (2011). Undergraduate research experiences in biology: Alternatives to the apprenticeship model. *CBE Life Sciences Education*, *10*(2), 123–131. https://doi.org/10.1187/cbe.11-03-0028

Williams, N., Hussain, H., Manojkumar, P., & Thapa, A. (2016). An evaluation of a STEM summer undergraduate research internship scheme: Student-perceived learning gains. *New Directions in the Teaching of Physical Sciences*, *11*(1), 1–9. https://doi.org/10.29311/ndtps.v0i11.581

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 152-170.
doi: 10.14434/josotl.v21i1.30552

Undergraduate Research Embedded Across Course Levels and Types through Scaffolded Projects

Sara Z. Evans
Kennesaw State University
sevan120@kennesaw.edu

Jocelyn Evans
University of West Florida

Abstract: This article explores how to embed an undergraduate research project within a course and summarizes the student experience in courses including undergraduate research. The authors specifically focus on how to modify and alter materials to fit with different course foci and different course levels. We have been leading an interdisciplinary, multi-year research project for the past four years. During that time, we have scaffolded a research project from year to year. Each piece of the project has been embedded within a course. However, the specific course level and content focus has changed from year to year. By embedding a research project within a class, faculty members have a unique opportunity to give their students a high-impact experience and further their own research simultaneously. We have successfully mentored and supervised students in the following formats: a freshman interdisciplinary honors course, two different undergraduate criminal justice courses made up of 5-10 students that were focused around criminological theory testing, individual directed study projects with graduate students, a 30-40 person upper level criminology research methods course, and a freshman individual directed study research project. Throughout all of these modalities, we have kept a core type of course design and course requirements but modified the components and grading criteria as needed for the type and level of course. We will summarize and discuss student assessment data both on their experience in the course as well as their achievement of student learning outcomes.

Keywords: Undergraduate research, course-based undergraduate research, and faculty professional development.

Introduction

The Council on Undergraduate Research (CUR) defines undergraduate research as "an inquiry or investigation conducted by an undergraduate student that makes an original intellectual or creative contribution to the discipline" (n.d.). Undergraduate research, scholarship, and creative activity (subsequently abbreviated as UGR) is designated as a high-impact practice (HIP) based on Kuh's original (2008) list. It has continued to be one of the most utilized and studied HIP experiences. There are three major areas of positive outcomes associated with participation in UGR. These include learning gains (either course specific or broader skills such as critical thinking) (Gray & Phillips, 2019; Lopatto, 2007; Ishiyama & Breuning, 2003), personal characteristics such as self-efficacy and self-esteem (Helm & Bailey, 2013), and a greater likelihood of persisting to graduation in a timely manner and acceptance into graduate/professional school (Ishiyama & Breuning, 2003).

While the benefits of UGR are well-documented (Brownell & Swaner, 2010), there are many challenges associated with engaging students in a high-quality UGR experience. Faculty have finite time and resources, and UGR typically requires more than the traditional classroom experience or individual research (Beer & Thompson, 2017). Providing a high-quality, valuable student experience is an important and vital part of engaging in UGR. However, faculty (especially untenured faculty) cannot ignore requirements to progress their careers through the achievement of tenure and promotion. While these two things may sometimes seem at odds, this article attests to the value of embedding undergraduate research across the curriculum and aims to provide faculty tools and strategies with which they can do both at the same time without sacrificing the quality of the experience.

Undergraduate research builds scholarly identity, improves retention, supports academic progress to degree completion, and develops soft skills that employers value. Given these benefits, institutions should encourage undergraduate research across the student academic career. Faculty engage in scholarly and creative activities within and across disciplines, and their classrooms provide valuable opportunities for including students in the research enterprise. In this piece, we report on a long-term interdisciplinary collaboration at a regional comprehensive institution involving undergraduate research across courses at different levels. Quantitative and qualitative assessment data highlight student gains and offer critical moments for reflection on best practices for faculty interested in weaving undergraduate research throughout their teaching.

Literature Review

Undergraduate Research as a High-Impact Practice

Existing scholarship on UGR highlights several dimensions of inquiry. Some researchers focus on UGR as HIP and measure the degree to which the UGR experience aligns with Kuh & O'Donnell's (2013) essential elements of a HIP. This research generally finds that when UGR experiences include most of the essential elements, they are more successful and students report better satisfaction (Kuh & O'Donnell, 2013). For example, surveyed students participating in UGR who reported greater effort and greater time investment from the faculty member (both essential elements) report greater benefits from the experience (Salsman, Dulaney, Chinta, Zascavage, & Joshi, 2013).

Other studies focus on measuring the degree to which students meet desired learning outcomes that theoretically should be associated with UGR as a HIP. To measure critical thinking and communication skills, some faculty use the Association of American Colleges & Universities (AAC&U) VALUE rubrics for these learning outcomes (Rhodes, 2009). Campus outlets for the presentation of student posters often include an undergraduate research showcase. Gray & Phillips (2019) present results indicating that students who engaged in UGR and presented that work were able to achieve above average skill scores for all dimensions on the VALUE rubrics. Additionally, their results show excellent interrater reliability using the rubrics, suggesting these rubrics are a promising instrument for assessing UGR (Gray & Phillips, 2019).

While there is less longitudinal research on the benefits of HIPs, some studies do exist. Participation in HIPs in college predicts higher levels of civic engagement in adulthood, even when controlling for potential selection effects. This includes research with a faculty member (Myers, C. B., Myers, S. M., & Peters, 2019). Additionally, the total number of HIPs a student participates in is a greater predictor of civic engagement than any one type. Lopatto (2011) used the Survey of Undergraduate Research Experiences (SURE) data to assess the impact of UGR. Results indicated that the majority of students who participated in UGR sustained or increased their interest in postgraduate education and reported the highest learning gains in "understanding of the research process in your field" (Lopatto, 2011). Taken together, these findings provide important evidence that HIPs in undergraduate education can have lasting impacts.

Finally, growing evidence suggests combining two HIPs in the same experience can have even greater impacts on learning. Combining undergraduate research with a learning community, for example, can enhance learning amongst first-year students (Mumford, Hill, & Kieffer, 2017). Students benefit from the intentional design of integrating HIPs together, and the collaborative learning environment serves to facilitate deeper learning of the research content. Data on alumni-reported gains and employment/post-graduate benefits suggest that participating in UGR has a powerful impact on the pursuit of graduate education, securing employment, and perceiving learning gains such as higher-order thinking (Schmitz & Havholm, 2015).

Undergraduate Research and Progression of Academic Career

Faculty members have many competing demands for their time and energy. The allocation of time and resources depends greatly on the workload assignment that is required by the type of institution. For most faculty, this involves some allocation of time toward teaching, research, and service. At institutions where teaching is the primary responsibility, faculty often feel that teaching and research expectations are at odds with one another (Ronnenberg & Sadowski, 2011). This becomes even more complicated and difficult with the addition of a HIP such as UGR. Providing a high-quality experience in UGR requires more time and effort than a traditional classroom environment (Beer & Thompson, 2017). While we recognize that this may be true, we argue that faculty can also be strategic about the way they design their courses and research projects to maximize time and energy. Embedding UGR within a course can also have benefits such as the inclusion of many more students than would be possible in a directed study format, which not only can increase the overall impact of the research experience, but it can also increase data generated from an individual project.

Many colleges and universities do not have formal policies by which to recognize excellence in UGR, especially if it happens outside the normal teaching load. Even if this work is embedded within an 'in-load' course, formal policies do not typically reflect the increased time needed for UGR compared to a typical class. Furthermore, disciplinary differences impact the degree to which this type of work is valued (Schultheis, Farrell, & Paul, 2011). Formal recognition of UGR in tenure and promotion criteria is needed and can take many forms (Rohs, 2011; Ronnenberg & Sadowski, 2011; Schultheis et al, 2011). While pushing for formal recognition of investment in UGR as a high-impact practice, faculty can implement other strategies to increase the impact and long-term use of the research they conduct with students, some of which are outlined and discussed next.

The Role of Mentoring in Undergraduate Research

Conducting a thorough review of the literature on undergraduate research, Linn, Palmer, Baranger, Gerard, and Stone (2015) demonstrate that mentors are crucial to the success of these high-impact experiences. Mentoring meets two significant goals when successfully implemented. Mentors help students deepen their scientific understanding as well as see themselves as emerging researchers.

> Mentors ideally orient undergraduates to develop and integrate (i) conceptual knowledge and background information in the topic of the research experience; (ii) science practices such as developing an argument from evidence; and (iii) insights into the culture of the lab, including the requirements of the funding and the roles of the participants. Mentors guide students to form a scientific identity by helping them imagine roles they can play in the lab, recognize gaps in their knowledge that future courses will fill, and identify ways to contribute that also strengthen their current capabilities (Linn et al., 2015:629).

Keller, Logan, Lindwall, and Beals (2017) outline a multi-dimensional support model for mentorship developed as a diversity initiative to benefit undergraduate students from traditionally underrepresented backgrounds who are aspiring researchers. They identify three distinct roles for mentorship, including peer mentors, career mentors, and research mentors. Though their model pertains to the health sciences, it is easily transferable to a variety of disciplines. It only requires student peers, faculty, and research assistants in the form of lab supervisors, undergraduate student mentors, or graduate students. Keller et al. (2017) argue that the participants in this model support students holistically across the "academic, psycho-social, and research domains by virtue of their roles as faculty, peers, and researchers."

The perspectives of mentors and mentees concerning the benefits and challenges of mentoring provides valuable insight. Gunn, Lee, and Steed (2017) find that "Mentors reported the process of *role modeling* to be most beneficial yet challenging. Mentees reported *psychological and emotional support* to be most beneficial, but *academic and knowledge support* to be challenging". In an article that summarizes the student perspective on mentoring, Pita, Ramirez, Jaocin, Prentice, and Clark (2013) outline five essential elements that students identify are needed in a mentoring relationship, which include making yourself available, fostering community, being attentive, encouraging participation in a broader research community, and being understanding. All of these elements generally align with research conducted by scholars in this area and again come back to one of the central elements of HIPs, which is to increase high-quality student engagement.

This conforms to existing scholarship on mentoring as a first-year initiative. Institutions often structure peer-mentoring programs to support the freshman cohort because these programs are linked to student engagement and increased retention. Yomtov, Plunkett, Efrat, and Marin (2015) find that students with peer mentors "felt significantly more integrated and connected to their university at the end of their first semester compared with non-mentored students." Their results suggest that these programs help with student integration and support, which in turn reinforces retention and persistence (Yomtov et al., 2015). Honors programs often combine common curriculum in the first year with peer mentoring and living-learning opportunities to build community, improve college readiness, and grow retention.

In sum, existing scholarship on undergraduate research suggests its utility as a high-impact practice, particularly when it includes all of the essential elements of a HIP. As a HIP, undergraduate research yields significant gains for students. Done well, it improves retention and academic progress. It also enhances critical thinking, communication, and civic engagement. These are important institutional goals and student learning outcomes for undergraduate students across the curriculum. However, engaging students in UGR takes a great deal of time, effort, and resources, which can be in short supply to faculty with active research agendas. Formal and informal mentorship can help to some extent, assisting students in developing a scholarly identity and deepening their scientific understanding. It is our contention, however, that even without significant resources, faculty can adopt a pedagogical approach of scaffolding UGR throughout their course load to benefit students and advance their research agenda. We suggest that faculty can 'work smarter, not harder' when it comes to UGR.

The Current Study

The current study describes a multi-year, interdisciplinary research project that has involved multiple courses. We have embedded undergraduate research in courses across a variety of formats: a freshman interdisciplinary honors course; two different special topics courses in criminal justice made up of 5-15 undergraduate students focused on investigating crime and public space; multiple directed study projects with graduate students; and a 30-40 person upper-level criminology research methods course. While this project has had multiple iterations, the assessment data in this study focus specifically on two courses: one semester of a freshman level honors course, and one semester of a special topics criminal justice course (400 level with sophomores, juniors, and seniors). We recognize that the honors population is unique, typically drawing high-achieving students. Honors programs often suffer from a lack of diversity. However, honors curriculum provides opportunities for interdisciplinary and team-based learning through foundational experiences. It also challenges students across majors to engage in research absent any training or prior knowledge. Table 1 presents demographic characteristics of the student population participating in the freshman course used in this study to highlight the potential for embedded undergraduate research throughout the curriculum. It also provides the distribution of declared majors. In terms of the honors students, 16% self-identified as nonwhite. An additional 5% identified as Hispanic. Approximately 70% of the population self-identified as female. In terms of declared majors, only 8% of the class had a declared major in the social sciences—the orientation of the faculty leading the undergraduate research experience in the courses included in this study. Unfortunately, information on declared major is no longer available for the criminal justice students, but demographic information for this group is included in Table 1, as well. This group was split in half in terms of males and females and had a slightly more diverse racial/ethnic makeup, with about 33% identifying as nonwhite.

The institution at which these projects took place is a mid-sized, regional comprehensive university in the Southeast. At the time of the projects, student enrollment was about 10,000 undergraduate students. The experiences discussed in the present study attest to the benefits of a scaffolded approach to UGR. Faculty can maximize time and effort by intentionally designing research projects to be embedded within multiple courses and with various sizes of student groups. In this study, we focus on three separate courses within the overall project and examine direct and indirect measures of student learning outcomes, highlight relevant assessment instruments, and provide supportive evidence of scaffolded UGR as best practice.

Pedagogical Approach of Scaffolded Undergraduate Research

One strategy that can be utilized by faculty is to scaffold their research projects over time to work on smaller parts of a bigger research question with multiple groups of students. We encourage faculty to conceive of their broad research agenda as a funnel (see Figure 1). First, consider the 'big' question that defines the research agenda. Then, distill the question into multiple smaller research questions that could potentially be answered in the confines of one semester. By approaching a research question in this way, faculty members are able to complete meaningful sub-projects that can contribute to a larger body of results/data. Consider the types of data that could be collected and identify distinct modes of data collection to contribute to a robust data set. Finally, arrive at a single approach to addressing the research puzzle that is well-suited to examination by undergraduate students in the parameters of a course or set of courses. Assignments and assessments can also be used in multiple venues to maximize time and effort.

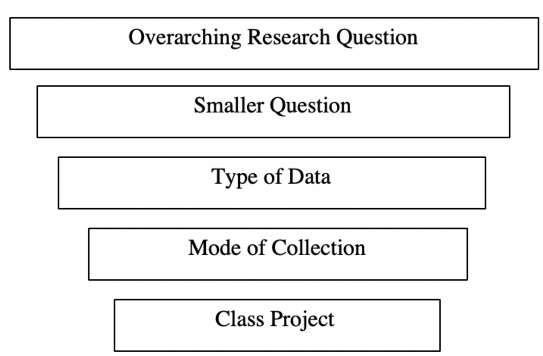

Figure 1. Conceptualizing Research Agenda for UGR.

Designing a Long-Term Project

The project outlined in this article began with the question, "What is the role of public space in shaping community relationship dynamics?" We intentionally crafted a broad research question for several reasons. First, it created the ability to break off smaller research pieces that could be addressed with different groups of students. Second, it provided ample opportunity for interdisciplinary collaboration to lighten the load of student management. Figure 2 shows how this project was divided into smaller pieces. Over the course of four years, student groups of varying sizes and disciplines addressed each of these questions. For example, in the first year of the project, a large, freshman-level honors course collected observational data using standardized indices. This was most appropriate for this course level and student population. The following year, this data collection was repeated but was supplemented by a smaller group of criminal justice majors enrolled in a special topics class who collected survey data by approaching individuals face-to-face and asking them to participate in the study. We set a higher benchmark for criminal justice students in terms of both content knowledge and research methods. Additionally, we worked with individual students on directed study projects related to this overall question.

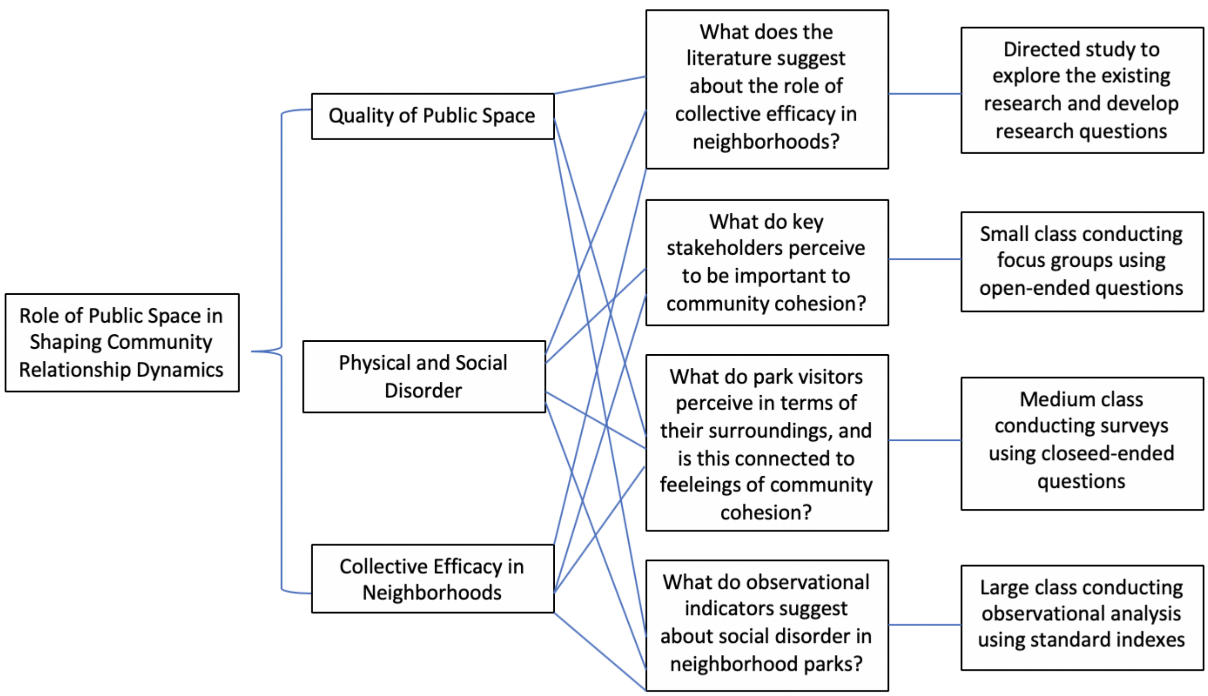

Figure 2. Interdisciplinary Research Question and Sub-Questions.

One of the most impactful aspects of this research project (especially in terms of the ability to embed a project in a course of 50+ students) is the interdisciplinary nature of the work. By bringing together multiple faculty members to work on the same project through different lenses, we generate exponentially more data with less time and effort on each individual instructor. We caution faculty members to choose their collaborators wisely, but forming a research team that is complementary in terms of disciplinary expertise and student management skills can be incredibly fruitful. Ryser, Halseth, and Thien (2009) argue that multi- and interdisciplinary teams can bring together disparate disciplinary perspectives that can fit together like a jigsaw puzzle and contribute to the whole.

Lastly, carefully consider instruments for data collection. What instrument can multiple groups of students use in successive years to build a larger dataset? Observational and/or survey data can often be valuable even if it contains data collected at multiple time points, assuming they are obtained within a reasonable timespan. Relatedly, intentional data collection across courses can yield robust results within just a few years. Consider how to build a multifaceted dataset by targeting individual pieces with specific groups of students. For example, a small group of students could conduct focus groups one semester to refine a survey instrument and provide qualitative data. The following semester, a larger class of students could administer the survey to respondents. Future groups of students could help analyze the data to answer their own research questions. If implemented with the essential elements of HIPs included, all of these could be valuable and impactful undergraduate research experiences.

Designing Course Assignments and Assessments

Another strategy that has been particularly useful has been to design course assessments and assignments so that they may be used in multiple venues. For example, we use an index to measure student experience in our courses (adapted from Gordon, Barnes, & Martin, 2009). Designed with a breadth of assessment of UGR in mind, the index is appropriate for administration across multiple groups of students with little modification. See Table 2 for this index, which is used to measure the impact of a criminal justice HIP outlined in Abderhalden, Snyder, and Evans (2016). This table contains results from two different courses, the results of which are discussed below.

Secondly, we utilize assignments and rubrics from our own prior courses to lessen the load of course design. Although our courses range from a freshman honors course, to a small criminal justice course, directed study students, and a criminal justice research methods course, there are many elements of assignments and rubrics that can be reused. For example, both the freshman-level honors course and the criminal justice course require a research project. Understandably, the expectations for students in these two courses are different. However, the elements that make up a 'research paper' remain largely the same. The detailed requirements for each element of the paper change. Table 2 shows one final paper rubric modified for use in various levels of courses. We use this particular example in a freshman-level honors course, but it can easily be revised for application in other contexts. Rubrics used across courses retain essential categories for assessment of research activities; the point values assigned to each of those categories vary based on the level of the course. Additionally, the detailed description of what is required for meeting and exceeding expectations varies based on the course.

A third place that assessments can be recycled to save time is in the development of reflection activities. Critical reflection is a key element of HIPs (Kuh & O'Donnell, 2013). Allowing students the space and time to reflect and integrate their learning can have powerful impacts on their long-term learning. There are a number of existing models for critical reflection; one of the most commonly used is the DEAL model developed by Ash and Clayton (2009). Regardless of model, faculty members can utilize similar instruments for critical reflection across multiple groups of students. Linn et al. (2015) emphasize the need for critical reflection and integration of learning based on their investigation of 60 studies on UGR.

Providing Mentorship Given Resource Constraints

Although mentorship of undergraduate researchers can take substantial time and energy to do well, there are also opportunities to maximize effort in this area. As mentioned above, peer mentors can provide valuable support to lighten the load on the instructor. This could take the form of either upper-level undergraduate students or graduate students. These students can be an important asset in mentoring students. There are many tasks such as managing schedules, distributing documents and materials, and answering questions that graduate students are well-prepared to do but undergraduate students could also be trained to excel at. Not all faculty have the availability of paid graduate assistants, but targeting students with similar research interests (either within the faculty member's discipline or outside it) can result in productive collaborations. Graduate students who participate in mentoring undergraduates can learn valuable leadership and supervisory skills, as well as advance their own research agendas. One graduate student who supervised a group of undergraduates in a criminal justice class remarked:

> The most important lesson I think I learned from this class came not from the class room or the data collection but from interacting as a graduate student with undergrads….this class was a real eye opener for me as to how to deal with other students and how sometimes a leader's expectations are not met.

This student recently completed a Ph.D. and was able to begin developing her skills as a leader early in her master's program because of participation in UGR.

The second and perhaps even more simple way that faculty can maximize effort in mentoring is to keep a file of information that is transferable across UGR experiences. To be clear, quality mentoring involves personalizing the experience for each student and each research project. However, there are many questions and issues that will likely occur repeatedly across situations. Faculty members can save time by keeping records of email responses, instructions, and even a list of 'frequently asked questions' that can be distributed to students in more than one specific project. One way to facilitate this is to create an online module that can be incorporated in multiple courses through the learning management system.

Assessment Data Supporting Pedagogical Approach

The following sections describe several types of assessment and present results from those assessments stemming from three iterations of the large-scale research project discussed in this article (one honors freshman course and two criminal justice special topics courses centered around a research project). The analysis includes results from student assessment of the experience, assessment of achievement of student learning outcomes, and critical reflection assignments. The university IRB approved the data collected for these assessments, and all students represented in these results signed informed consent documents allowing their responses to be used for research purposes.

Assessment of UGR Products and Student Learning Outcomes

The assessments we utilize for these various UGR experiences are not exactly the same. Unfortunately, the audience for course assessment varied and led to inconsistent evidence. For example, the honors course provides macro student-learning outcome data to the institution's coordinator of general education. The criminal justice courses were both funded in part by the university Quality Enhancement Plan (QEP). As a result, the QEP dictated the shape and purpose of the assessment. However, in the same way that we utilize rubrics that have been modified across different courses and can compare results of overall scores across courses, we still can provide some summary comments based on the percentage of students who met or exceeded expectations, even if the exact benchmarks reflecting the achievement of those milestones slightly differ. Given that, results are not exactly replicable across courses, but the assessments and assignments were similar enough to present them together.

For the upper-level criminal justice students, the primary learning outcomes involved written and oral communication. The undergraduate students completed poster presentations in groups and presented these in a public forum (graduate students also completed a research paper). The first class conducted their own poster session, which was attended by faculty and administrators from within the college. The second class participated in the university student scholar symposium. Items on the rubrics assessing oral communication skills include measures such as "uses sources that are appropriate and relevant," "language and content serve the intended purpose of the communication," and "states a clear conclusion that is consistent with the evidence presented." Evidence indicates that in both iterations of the course, over 75% of the students either met or exceeded expectations for all domains of communication skills (rubrics available upon request). Furthermore, the majority of students earned either an A or B for the course overall, indicating a successful grasp of content-based learning outcomes. This course included a variety of students with regards to experience in research, major, class year, and GPA. Given that, a high grade in this course was not necessarily expected for everyone.

The honors course meets a general education requirement. Consequently, the metrics for assessing student learning outcomes differ. Students in the honors course work in small groups to complete focused segments of the overall research project, which they presented at a panel presentation in the student scholar symposium. Given the level of the course, the main learning outcomes assessed for this class are teamwork and integration of knowledge from throughout the course. Over the course of the semester, 82% of students met or exceeded expectations for teamwork, and 80% of students met or exceeded the benchmark for synthesis of information. Furthermore, 84% of students reported that they felt work with their peers facilitated learning. Select students from all of these courses were accepted to present at the Southern Criminal Justice Association and the American Society of Criminology annual meetings.

Assessment of Student Experience

To capture an indirect measure of student learning, we utilized the assessment instrument developed by Gordon, Barnes, and Martin (2009). The instrument is on a scale from 1-4, with 1=Strongly Agree; 2=Agree; 3=Disagree; and 4=Strongly Disagree. Table 3 presents the battery included in the assessment instrument. We adapted their original rating scheme and augmented it with additional measures to capture student perceptions related to the general education learning outcomes of the freshman honors course. These items focus on interdisciplinary thinking, synthesis of information, and project management. We report these measures here because of their connection to the goals of undergraduate research as a high-impact practice.

Table 3 reveals some key findings across both student populations. One student enrolled in the upper-level criminal justice course (represented in the demographics in Table 1) elected not to complete the course assessment, and as a result, there is a discrepancy in the N for Tables 1 and 2. Students in both courses by and large reported a great deal of engagement with classmates and instructors. They recognized that the course required more than rote memorization of material, instead asking them to engage in active learning and direct experience. They did not find these courses to be easier than they expected them to be. Class attendance and participation, small group discussion, and instructor/student engagement (through Q&A) were vital to success. Students did find that working with their peers to be a good way to facilitate learning. Honors students reported interdisciplinary thinking, information synthesis, and project management.

There are some notable differences in the responses of the two student populations. The students in the upper-division criminal justice course reported learning much more from field research and hands-on research than a traditional classroom experience. They also reported learning more about themselves through the hands-on experience. The honors students did not report as many gains in these dimensions. The upper-division students also appear more likely to recommend the experience to a friend. Perhaps some of this variance is attributable to the selective nature of the honors program, as well as the limited access of this cohort-based course.

Critical Reflection Results

The final essential type of assessment is critical reflection. In each of the iterations of this research project, students engaged in critical reflection. Students reflected on their experience after their first time in the field and then again after subsequent trips. Lastly, the end of semester feedback includes some form of reflection. For the upper level criminal justice courses, this involves a reflection paper; for the lower-level honors course, this takes the form of short responses about the experience. While not all students report enjoying the research part of the course, many have positive things to say. Please note that these reflection quotes are taken from these two different course experiences, so the implications of them differ, but we specify what level of student reported each. One freshman honors student remarked, "I liked the learning experience that the field experience had to offer and how I had to overcome different obstacles and realize that some things just don't work out like you think they should." We stress for all students that flexibility is important. Students often are surprised by the challenges encountered during data collection. In a final reflection paper, one of the upper-level criminal justice students said, "Overall from this class and from data collection I have learned a lot. I learned how to be a better researcher and how to apply classroom knowledge to actual hands on application."

In addition to benefits associated with content knowledge and research skills, several students commented that they were able to enhance personal characteristics such as confidence in interacting with strangers, as indicated by this criminal justice student's comment:

> The biggest impact in my personal learning experience was the direct interaction with the campers as I was forced out of my shell (so to speak) and I gained valuable experience with dealing with them and with approaching them which has been the recurring most difficult part of interacting with strangers in my case. This is going to be extremely helpful not only in my career, but also in my day-to-day interactions and experiences with people…

A number of other students had similar remarks, indicating that they not only increased their knowledge and skills related to research, but they also developed broader transferable skills.

Discussion

Results from the current study provide further corroboration and support for existing literature on UGR as a HIP. Over the course of several years and with different levels of students, we consistently demonstrated benefits such as increased communication skills, teamwork, and content-based learning outcomes. There were some differences in the learning gains based on student population. For example, upper-level criminal justice majors reported that the field work they conducted was more meaningful to their learning than the time they spent in a traditional classroom. This is likely due to differences in data collection methodology and the level of students in each class. The criminal justice students administered surveys on multiple days for long stretches under the constant supervision of instructors. There were ample opportunities both in the field and in the classroom to talk about the research project and reflect on the value of the experience. The freshman honors students were given some of these same opportunities, but their course was not solely focused on the research project. Some students collected survey data while others collected observational data. As a result, some students never interacted with human subjects in the field. Additionally, data collection was done over shorter periods of time in small groups rather than by the whole class synchronously. Furthermore, students sharing a declared major and several program requirements most likely would be more prepared for real-world application of content than freshman from different majors in an interdisciplinary course satisfying a general education and honors requirement.

Based on the results of this collaboration, faculty considering long-term collaborative research projects involving undergraduate students should set appropriate expectations for gains in learning outcomes relative to class size, student population, and diversity of majors. Faculty should consider the degree to which supervision, reflection, and synthesis are linked to student gains. Formal or informal peer mentoring and interdisciplinary partnerships might help faculty achieve the benefits of undergraduate research as a high-impact practice in situations where institutional or departmental resources are scarce.

The second goal of this article was to provide suggestions that faculty members can implement in their own teaching and research to maximize time and effort. Forethought and early planning can lead to a high-quality experience for the students involved and a better, more valuable research product for faculty members. The projects outlined here and other related interdisciplinary UGR projects have resulted in four peer-reviewed publications, approximately 60 research posters (one of which won second place at the university symposium and one of which won best student poster at a regional criminal justice conference), two full thematic panel presentations at a national conference, and a grant proposal to a national funding agency. Additionally, there are at least seven students so far that credit their participation in this project as being integral to the decision to attend graduate school. One of those students recently completed a Ph.D. These results emphasize the point that economizing time and energy does not imply compromising quality or lowering expectations. With adequate planning, both can be achieved simultaneously.

While the projects outlined here have been largely successful, there are limitations that we hope to address in future research. First, the assessment was not a double-blind assessment of work, and we acknowledge the potential introduction of bias. Given the nature of the assessments as course assignments (including some oral presentations), it was not possible for the instructors to conduct assessments of student work without knowing their identities. Second, it is possible that some higher-performing students self-selected themselves into these experiences, and a portion of the successful outcome could be attributed to this phenomenon. However, as we discussed above, we had a variety of students represented in both courses. Lastly, we had the benefit of including several graduate students to assist in mentoring students through some of these projects, and we acknowledge that this is not an option for many faculty members at teaching-focused institutions. We encourage faculty members to also consider inviting upper-level undergraduate students to serve as peer mentors as another option.

Conclusions and Implications

While assessment tools and results from one large project are presented here, there is room for improvement in several areas. Perhaps most importantly, there is a need for more consistency in assessment of UGR as a HIP to validate the benefits outlined here and in other studies. Most claims about the impact of UGR are largely based on self-reports from students, and many lack standardized assessment or assessment of learning gains based on research products (Linn et al. 2015). The scholarship on assessment in HIPs offers potential scales by which to measure self-efficacy and scientific literacy (Sams et al., 2015). Additionally, a recent article by Finley (2019) lays out a comprehensive plan for assessing HIPs. In the future, we plan to utilize validated assessments to further add to this body of research.

Great need exists for systematic and programmatic changes to increase participation in undergraduate research. In a study of one psychology department with approximately 550 majors and 21 faculty members, Wayment and Dickson (2008) underscore this need. Barriers to participation in UGR include lack of awareness of opportunity, lack of a formalized system to involve students, poor timing in curriculum, no outlet for dissemination, and uneven compensation for faculty who supervise UGR. Implementation of structured changes to address each of these barriers led to significant and substantial increases in UGR participation (Wayment & Dickson, 2008). Changing policy and departmental bylaws are both effective and important ways to ensure recognition for UGR, but this is not always possible given particular climates at the departmental/college/university levels. For this reason, we intentionally provide strategies that do not rely on large-scale policy changes.

It is important to recognize the difference in class size across our student populations. The directed studies and upper-division courses were smaller than the freshman honors course. It might be that students in larger courses see less relative value in the undergraduate research experience compared to students in capped upper-division courses. Freshmen taking general education requirements often are in courses outside of their majors and bring fewer course experiences by which to compare the activity.

Students come to the classroom from diverse backgrounds. Engaging freshmen in high-impact, hands-on research activities promote retention and progress towards degree completion. It helps these students develop their identity as research scholars. It might be, however, that more advanced students recognize the added value of these experiences more readily. They have more coursework by which to compare the structural differences in the pedagogical approach and the opportunity for real-world application and skill development. This article outlines strategies by which faculty members can more efficiently and effectively scaffold their undergraduate research projects across multiple venues with different student groups. We suggest that with intentional planning, a faculty member can save time and resources while still designing a high-impact experience for students and generating high-quality data.

Acknowledgments

The authors would like to thank Dr. Jamie Snyder and Dr. John D. Morgan for their contributions in the early stages of this work. We would also like to thank Dr. Frances Abderhalden for her tireless work as an undergraduate and graduate student.

Appendix

Appendix 1. Table 1. Demographic Characteristics of Student Populations.

	Honors (n=60)		CJ (n=12)	
	Percent	N	Percent	N
Gender				
Male	29%	18	50%	6
Female	71%	44	50%	6
Race				
Black	8.1%	5	8.3%	1
Asian	3.2%	2	16.7%	2
Pacific Islander	1.6%	1	0%	0
White	83.9%	52	66.7%	8
Ethnicity				
Hispanic	4.8%	3	8.3%	1
Non Hispanic	95.2%	59	91.7%	11
Declared Major			****	
AA	1.6%	1		
Arts	8.1%	5		
Business	8.1%	5		
Humanities	4.8%	3		
Mathematical Science	11.3%	7		
Natural/Health Science	45.2%	28		
Professional	4.8%	3		
Social Science	8.1%	5		
Undecided	8.1%	5		

Appendix 2. Table 2. Example Research Paper Rubric.

Research Paper Rubric **Name:**____**Date:**________________**Score:** __________

Category	Exceeds Standard	Meets Standard	Nearly Meets Standard	Does Not Meet Standard	No Evidence	Score
Research question	Clearly and concisely states the paper's research question in a single sentence, which is engaging, and thought provoking. (5)	Clearly states the paper's research question in a single sentence. (4)	States the paper's research question in a single sentence. (3)	Incomplete and/or unfocused. (1)	Absent, no evidence (0)	
Introduction	The introduction is engaging, states the main topic and previews the structure of the paper. (5)	The introduction states the main topic and previews the structure of the paper. (4)	The introduction states the main topic but does not adequately preview the structure of the paper. (3)	There is no clear introduction or main topic and the structure of the paper is missing. (1)	Absent, no evidence (0)	
Organization-Structural Development of the Idea	Writer demonstrates logical and subtle sequencing of ideas through well-developed paragraphs with main ideas; transitions are used to enhance organization. (5)	Paragraph development present but not perfected. (4)	Logical organization: organization of ideas not fully developed. (3)	No evidence of structure or organization. (1)	Not applicable (0)	
Grammar	No errors in punctuation, capitalization, spelling, sentence structure, or word usage. (10)	Almost no errors in punctuation, capitalization, spelling, sentence structure, or word usage. (7)	Many errors in punctuation, capitalization, spelling, sentence structure, or word usage. (3)	Numerous and distracting errors punctuation, capitalization, spelling, sentence structure, or word usage. (1)	Not applicable (0)	
Citation	All cited works, both text and visual, are done in the correct format with no errors. (5)	Some cited works, both text and visual, are done in the correct format. Inconsistencies evident. (4)	Few cited works, both text and visual, are done in the correct format. (3)	Absent (1)	Not applicable (0)	
Bibliography	Done in the correct format with no errors. Includes more than 5 major references (e.g. science journal articles, books, but no more than two internet sites. Periodicals available on-line are not considered internet sites) (5)	Done in the correct format with few errors. . Includes 5 major references (e.g. science journal articles, books, but no more than two internet sites. Periodicals available on-line are not considered internet). (4)	Done in the correct format with some errors. Includes 4 major references (e.g. science journal articles, books, but no more than two internet sites. Periodicals available on-line are not considered internet). (3)	Done in the correct format with many errors. Includes 3 major references (e.g. science journal articles, books, but no more than two internet sites. Periodicals available on-line are not considered internet sites.) (1)	Absent or the only sites are internet sites. (0)	

Table 2 (cont'd).

	Exceeds Standard	Meets Standard	Nearly Meets Standard	Does Not Meet Standard	No Evidence	Score
Literature Review	Uses multiple sources of scholarship to support attention to research question. Development is clear, logical, and organized.	Uses multiple sources of scholarship to support attention to research question. Development could be improved.	Uses multiple sources of scholarship, but less clear how these sources support attention to research question.	Uses limited sources of scholarship but lacks clarity concerning how these sources support attention to research	No sources of scholarship used to support research question.	/10
Data and/or Sources of Evidence	Lists all data sources in discrete section of paper. Indicates variables and coding.	List some data sources in discrete section of paper. Indicates variables and coding.	Has data section, but the section is not clear. No indication of variables and coding.	Data mentioned at times but not in a discrete section devoted to data. No indication of variables and coding.	No mention of data and/or sources of evidence.	/7
Method of Inquiry	Lists all methods of inquiry in a detailed, sequential order that are easily followed.	Lists all methods of inquiry in a sequential order, but is difficult to follow.	Lists all methods of inquiry but not clearly sequential and not easily followed.	Lists some method of inquiry but not sequential, not easily followed, or incomplete.	Does not list method of inquiry.	/3
Results or Findings	Analysis is organized in a clear manner. All illustrations are provided and clear.	Analysis is organized in a clear manner with few errors. All illustrations are provided and clear with few errors.	Analysis is organized but not clear and with errors. All illustrations are provided but not clear and with errors.	Analysis is provided but not clear and with major errors. All illustrations are provided but not clear and with major errors.	No analysis and no illustrations provided.	/20
Conclusion or Discussion	Engaging and restates the research question and answers it for the reader.	Restates the research question in the conclusion.	Answers the question in the conclusion but does not restate the research question.	Does not address the question or the answer to it in the conclusion.	No conclusion or discussion.	/10
Implications	Draws clear and accurate implications of work for key audiences.	Draws implications of work for key audiences but less clear and inaccurate.	Draws implications of work but not with key audiences in mind and lacks clarity and accuracy.	Limited attention to implications of work.	No implications provided.	/10

Appendix 3. Table 3. Quantitative Feedback from CJ Course (N=11); Honors Core 2 (N=63).

	Criminal Justice			Honors		
Question	Mean (std. dev.)	Min	Max	Mean (std. dev.)	Min	Max
My level of anxiety for this class was low before beginning.	2.45 (1.04)	1	4	2.22 (.924)	1	4
I had little interaction with my classmates.	3.63 (.67)	2	4	3.21 (.901)	1	4
I came to class prepared.	1.54 (.52)	1	2	1.89 (.764)	1	3
I had little interaction with my instructor.	3.55 (.69)	2	4	2.87 (1.008)	1	4
The class was as easy as I expected it to be.	2.73 (.65)	2	4	2.89 (.785)	1	4
Memorization of the material is all I needed to do in order to do well in this class.	3.63 (.67)	2	4	2.98 (.871)	1	4
This course allowed me to engage in activities, problems, and tasks.	1.09 (.30)	1	2	1.62 (.658)	1	3
I learned through direct experience in this class.	1.09 (.30)	1	2	1.84 (.865)	1	4
I had to think about problems from different academic disciplinary perspectives.				1.59 (.816)	1	4
Information from multiple academic disciplines improved my understanding of complex problems.				1.83 (.890)	1	4
I had to evaluate course readings in terms of the context in which they were created.				1.78 (.750)	1	4
I had to synthesize information from divergent sources and viewpoints and draw reasonable conclusions.				1.67 (.648)	1	3
I had to exhibit disciplined work habits as an individual.				1.65 (.744)	1	4
I had to conceive, plan, and execute a group service project.				1.44 (.667)	1	4
Working with my peers was a good way to facilitate learning.	1.18 (.40)	1	2	1.70 (.854)	1	4
My sense of community was enhanced.	1.18 (.52)	1	2	1.79 (.936)	1	4
I worked with students outside the classroom to enhance my learning.	1.55 (.52)	1	2	1.70 (.835)	1	4
I discussed the course material with others outside the class.	1.73 (.65)	1	2	1.63 (.848)	1	4
Attending class was important for learning.	1.18 (.40)	1	2	1.51 (.780)	1	4
	Criminal Justice			Honors		

Question	Mean (std. dev.)	Min	Max	Mean (std. dev.)	Min	Max
Participating in class was important for learning.	1.27 (.47)	1	2	1.97 (.967)	1	4
Small group discussions in class were important for learning.	1.55 (.52)	1	2	1.90 (.928)	1	4
Asking questions of instructors was important for learning.	1.36 (.50)	1	2	1.63 (.809)	1	4
Asking questions of peer students was important for learning.	1.27 (.47)	1	2	1.79 (.883)	1	4
I learned more in this class doing field research than in a traditional classroom.	1.27 (.65)	1	3	2.22 (.991)	1	4
This experience taught me more than books or lectures.	1.27 (.47)	1	2	2.03 (.999)	1	4
Through hands on experience I learned more about myself.	1.45 (.52)	1	2	2.22 (1.054)	1	4
I would recommend this class to a friend.	1.09 (.30)	1	2	2.21 (1.080)	1	4
I would take another class like this one with hands on learning.	1.27 (.47)	1	2	1.92 (.903)	1	4
*Adapted from Gordon, Barnes, & Martin, 2009						
questions were not included in CJ assessment						

References

Abderhalden, F., Snyder, J. A., & Evans, S. Z. (2016). Creating the code of the campground: Developing high impact experiences in criminal justice. *Journal of Criminal Justice Education, 27*(3), 410-431. https://doi.org/10.1080/10511253.2016.1144990.

Ash, S. L., & Clayton, P. H. (2009). Generating, deepening, and documenting learning: The power of critical reflection in applied learning. *Journal of Applied Learning in Higher Education*, *1*(1), 25-48. https://scholarworks.iupui.edu/handle/1805/4579.

Beer, F., & Thompson, J. (2017). Undergraduate and graduate research and creative activities: Faculty's evaluation, time commitment, and perceived barriers. A practice report. *Student Success*, *8*(1), 73-78. https://doi.org/10.5204/ssj.v8i1.329.

Brownell, J. E., & Swaner, L. E. (2010). *Five high impact practices: Research on learning outcomes, completion, and quality*. Washington, DC: Association of American Colleges and Universities.

Council on Undergraduate Research. (n.d.). Mission statement. Retrieved from https://www.cur.org/who/organization/mission/

Finley, A. (2019). *A comprehensive approach to assessment of high-impact practices* (Occasional Paper No. 41). Urbana, IL: University of Illinois and Indiana University, National Institute for Learning Outcomes Assessment (NILOA).

Gordon, J. A., Barnes, C. M., & Martin, K. J. (2009). Undergraduate research methods: Does size matter? A look at the attitudes and outcomes of students in a hybrid class format versus a traditional class format. *Journal of Criminal Justice Education*, *20*(3), 238-239. https://doi.org/10.1080/10511250903200493.

Gunn, F., Lee, S. H., & Madelyn S. (2017). Student perceptions of benefits and challenges of peer mentoring programs: Divergent perspectives from mentors and mentees. *Marketing Education Review, 27*(1), 15-26. https://doi.org/10.1080/10528008.2016.1255560.

Helm, H. W., & Bailey, K. G. D. (2013). Perceived benefits of presenting undergraduate research at a professional conference. *North American Journal of Psychology*, *15*(3). https://digitalcommons.andrews.edu/behavioral-pubs/63.

Ishiyama, J., & Breuning, M. (2003). Does participation in undergraduate research affect political science students? *Politics & Policy*, *31*(1), 163-180. https://doi.org/10.1111/j.1747-1346.2003.tb00892.x.

Keller, T. E., Logan, K., Lindwall, J., & Beals, C. (2017). Peer mentoring for undergraduates in a research-focused diversity initiative. *Metropolitan universities*, *28*(3), 50. DOI: 10.18060/21542.

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., & O'Donnell, K. with case studies by Sally Reed. (2013). *Ensuring quality and taking high-impact practices to scale*. Washington, D.C.: Association of American Colleges & Universities.

Linn, M. C., Palmer, E., Baranger, A., Gerard, E., & Stone, E. (2015). Undergraduate research experiences: Impacts and opportunities. *Science*, *347*(6222). DOI: 10.1126/science.1261757.

Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE – Life Sciences Education*, *6*(4), 251-360. https://doi.org/10.1187/cbe.07-06-0039.

Rhodes, T. (2009). *Assessing outcomes and improving achievement: Tips and tools for using the rubrics*. Washington, DC: Association of American Colleges and Universities.

Mumford, K., Hill, S., & Kieffer, L. Utilizing undergraduate research to enhance integrative learning. *CUR Quarterly, 37*(4), 28-32. https://go.gale.com/ps/anonymous?id=GALE%7CA504564024&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w.

Myers, C. B., Myers, S. M., & Peters, M. (2019). The longitudinal connections between undergraduate high impact curriculum practices and civic engagement in adulthood. *Research in Higher Education*, *60*, 83-110. DOI:10.1007/s11162-018-9504-4.

Pita, M., Ramirez, C., Jaocin, N., Prentice, S., & Clarke, C. (2013). Five effective strategies for mentoring undergraduates: Students' perspectives. *CUR Quarterly, 33*(3), 11-15. https://go.gale.com/ps/anonymous?id=GALE%7CA324399339&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w.

Rohs, C. R. (2011). Undergraduate research and the tenure and promotion process. *CUR Quarterly, 31*(4), 13-18. https://go.gale.com/ps/anonymous?id=GALE%7CA265098879&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w.

Ronnenberg, S. C., & Sadowski, J. (2011). Recognizing undergraduate research in criteria for faculty promotion and tenure. *CUR Quarterly*, *31*(4), 10-12. https://go.gale.com/ps/anonymous?id=GALE%7CA265098878&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w.

Ryser, L., Halseth, G., & Thien, D. (2009). Strategies and intervening factors influencing student social interaction and experiential learning in interdisciplinary teams. *Research in Higher Education*, *50*(3), 248-267. DOI: 10.1007/s11162-008-9118-3.

Salsman, N., Dulaney, C., Chinta, R., Zascavage, V., & Joshi, H. (2013). Student effort in and perceived benefits from undergraduate research. *College Student Journal*, *47*(1), 202-211.

https://www.ingentaconnect.com/content/prin/csj/2013/00000047/00000001/art00021#expand/collapse.

Schmiz, H. J., & Havholm, K. (2015). Undergraduate research and alumni: Perspectives on learning gains and post-graduation benefits. *CUR Quarterly*, *35*(3), 15-22. https://go.gale.com/ps/anonymous?id=GALE%7CA465166022&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w.

Schultheis, A. S., Farrell, T. M., & Paul, E. L. (2011). Promoting undergraduate research through revising tenure and promotion policy. *CUR Quarterly*, *31*(4), 25-31. https://go.gale.com/ps/anonymous?id=GALE%7CA265098881&sid=googleScholar&v=2.1&it=r&linkaccess=abs&issn=10725830&p=AONE&sw=w.

Wayment, H. A., & Dickson, K. L. (2008). Increasing student participation in undergraduate research benefits students, faculty, and department. *Teaching of Psychology*, *35*, 194-197. https://doi.org/10.1080%2F00986280802189213.

Yomtov, D., Plunkett, S. W., Efrat, R., & Marin, A. G. (2017). Can peer mentors improve first-year experiences of university students? *Journal of College Student Retention: Research, Theory & Practice*, *19*(1), 25-44. https://doi.org/10.1177%2F1521025115611398.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 171-192.
doi: 10.14434/josotl.v21i1.30553

Undergraduate Research Across the Psychology Curriculum: A Case Study and Program Assessment

Kevin M. Clark
Indiana University Kokomo
kevclark@iuk.edu

Rosalyn Davis
Indiana University Kokomo

Kathryn Holcomb
Indiana University Kokomo

Gin Morgan
Indiana University Kokomo

Abstract: Over the past 10 years, the Psychology Department at Indiana University Kokomo has worked to incorporate more opportunities for students to engage in undergraduate research throughout the psychology curriculum. Our previous requirements included a lower level methods course that most students took prior to statistics, with the result that students did not have the opportunity to practice the use of statistics in research contexts unless they completed an independent research project during their senior year. We made several curricular changes to enhance these opportunities to apply statistical knowledge, to increase research literacy and critical analysis, and to better prepare students who go on to complete an independent research project. The lower level methods course was redesigned to explore psychology as a major and career, introduce research concepts, and help students develop critical thinking skills. We also reinstated an upper level methods course with statistics as a prerequisite, allowing better integration of statistics with research methods. Most recently, in fall 2018, we added a lab to the upper level methods course, in which students use computer-based statistical software for data analysis. In addition to these curricular changes, the department has recently been promoting and facilitating more student travel to research conferences throughout the undergraduate program. In this article, we describe the program we designed to scaffold student research and present a six-level framework applicable across a broad range of disciplines. We also present data collected from current students and alumni in psychology to assess their perceptions of the impact of these changes on their research confidence and competence as well as limited results from assessment of student learning. Finally, we provide recommendations for other programs interested in increasing opportunities for student research in their disciplines.

Keywords: undergraduate research, teaching research methods, psychological inquiry, teaching of psychology, supervised research, experiential learning, high-impact practices

The field of psychology spans a broad range of topics. One of the key elements that binds psychological subfields together is the reliance on empirical methods of knowing (Stanovich, 2019). In 2013, the American Psychological Association (APA) published its second version of *Guidelines for the Undergraduate Psychology Major*, which includes five comprehensive learning goals to be incorporated into undergraduate psychology programs. Goal 2 is "Scientific Inquiry and Critical Thinking," which includes skills in scientific reasoning and literacy as well as basic research skills in the interpretation, design, and conduct of scientific inquiry. Stoloff et al. (2010) analyzed the responses of 374 psychology programs in North America that participated in online surveys collected by the APA. They found that, in practice, coursework in the broad domain of research methods and statistics was universally offered, and in 98% of those programs, research methods and/or statistics were required courses.

Although research methods and statistics are nearly universally required for undergraduate psychology majors, there is no consensus on how to teach these classes. Traditionally, these topics have been covered in separate classes, but some programs have combined them into a course sequence that integrates these subjects, such as Research/Statistics I and II (Christopher, Walter, Horton, & Marek, 2007; Stoloff, Curtis, Rodgers, Brewster, & McCarthy, 2012). This debate about how to structure the teaching of research methods and statistics focuses on whether these topics are best learned together or separately. While there are some logistical issues with combining methods and statistics, the main benefits are the ability to teach the statistics that are most appropriate for specific research methods while students are learning about them, and the ability to better incorporate student research projects into the extended time frame available in a two-semester research methods and statistics sequence (Christopher et al., 2007). Despite these benefits of combining methods and statistics, most programs keep these classes separate (Stoloff et al., 2010). One benefit of offering research methods and statistics separately is the potential to reduce anxiety among students taking these courses. Statistics and research methods courses have both been shown to elicit anxiety in students (Onwuegbuzie & Wilson, 2003; Papanastasiou & Zemblyas, 2008), and anxiety is negatively correlated with course performance (Freng, 2020; Onwuegbuzie & Wilson, 2003; Papanastasiou & Zemblyas, 2008). Further, higher performance in research methods courses is predictive of higher performance in upper level psychology courses, even after controlling for ACT scores and grade point averages (GPAs) before taking the statistics and research methods courses (Freng, 2020; Freng, Webber, Blatter, Wing, & Scott, 2011). Thus, students may fare better in research methods and statistics courses, and upper level courses in the major, if these anxiety-provoking courses are not taken in the same semester.

Another factor that may influence students' performance in research methods and subsequent courses is their perception of the subject area as a science. Friedrich (1996) developed the Psychology as Science scale. He found that greater belief in psychology as a science was associated with higher psychology GPA. Freng (2020) found that higher ratings on the scale were predictive of higher performance on the Psychology Assessment Test, but ratings of psychology as a science were not predictive of course performance in statistics, research methods, or upper level psychology courses. However, in Freng's study, students' beliefs about psychology as a science were assessed when they took introductory psychology, and these beliefs may change as students progress through the psychology curriculum. Freng did find that students who took research methods earlier in their student careers performed better in upper level psychology courses, even after controlling for ACT scores, the number of psychology courses students had completed, and their GPA in courses taken before research methods. Freng's interpretation was that developing an understanding of research methods early in their student careers may facilitate student performance in upper level courses.

Although students who are primarily interested in clinical subfields of psychology may not intuitively view research methods as applicable to their career interests, Freidrich (1996) found that students' views of psychology as a science were also associated with applied areas of psychology; students who scored higher on the Psychology as Science scale held more positive attitudes about psychotherapy efficacy and were more willing to seek psychotherapy. In their study of attitudes toward research, Papanastasiou and Zemblyas (2008) found that students' belief that research was useful for their profession was highly predictive of their final grade in their research methods course, with higher ratings of usefulness predictive of higher final grades. Although this research is correlational, an early introduction to psychology as a science, and early orientation to the role that science plays in different careers in psychology, may facilitate student engagement and performance throughout the research program.

In addition to shaping perceptions, participation in research is beneficial to students as a high-impact practice. Increasingly, high-impact practices have been investigated to assess their effectiveness in learning (Kuh, 2008). High-impact practices are teaching techniques that have been empirically demonstrated to improve student learning and retention; they include undergraduate research as well as collaborative student projects (Kilgo, Ezell Sheets, & Pascarella, 2015). The undergraduate research methods sequence in psychology provides an ideal way to implement high-impact practices because of its emphasis on skills development, as well as its use of collaborative research teams. Although earlier investigations did not find group projects to be common in the majority of research methods syllabi (Landrum & Smith, 2007), collaboration provides an opportunity for students to participate in research in a way that is similar to how research is typically conducted in psychology and other sciences. In addition, the APA (2013) advocates using authentic assessment for the outcomes associated with this goal, including students conducting research independently or in teams.

Thus, research methods and statistics have an important role in the psychology curriculum. For faculty seeking to evaluate and improve their research course sequence, an important first step is to identify what, specifically, they want their students to know and be able to do relating to research. These learning outcomes can then guide curriculum revision efforts in a process called backward design. In their discussion of backward curriculum design, Wiggins and McTighe (1998) identified three stages: (a) identifying learning outcomes, (b) identifying how achievement of those learning outcomes will be assessed, and (c) identifying pedagogical approaches and student experiences designed to achieve those learning outcomes. Wiggins and McTighe also described four criteria that may be used to identify potential learning outcomes: what will have lasting and broad applicability, what is central to the discipline, what students tend to have difficulty with, and what is interesting and engaging to students. We believe that undergraduate research experience meets all these criteria. Although he focused on course design rather than curriculum design, Fink (2013) also emphasized backward design, with the added steps of identifying situational factors (e.g., the context of the course, class and student characteristics) and of ensuring integration among learning outcomes, assessment, and pedagogical approaches and student experiences.

It is important that such integration occurs not just within each course but also at the program level (i.e., across the major). If the curriculum is just a collection of separate courses, students may learn concepts in one course but never have the opportunity to review, practice, apply, and/or build upon these ideas in later courses (Maki, 2002). According to Suskie (2018), "Student learning is deeper and more lasting when students can see connections among their learning experiences. . . . Learning experiences should therefore be purposefully designed as coherent, integrated, and collaborative, building upon and reinforcing one another" (p. 19). This seems especially important for research concepts and skills, which are challenging for many students and thus will likely require multiple exposures with repeated practice before students achieve mastery and can apply these conceptual, analytic, and methodological tools in meaningful research contexts.

A coherent curriculum assists students in achieving program learning outcomes by providing connected learning experiences across multiple courses as well as cocurricular experiences (Maki, 2004; Suskie, 2018). Ongoing program assessment provides a context for continued attention to improving curriculum coherence and identifying areas where students lack sufficient learning opportunities or support to achieve program outcomes (Maki, 2002; Suskie, 2018). Curriculum mapping—that is, identifying which courses and learning experiences provide opportunities to introduce, reinforce, and emphasize each learning outcome—can help faculty visualize program learning opportunities and identify misalignments or gaps (Maki, 2004). If effective, a coherent curriculum provides students with "*multiple, iterative* opportunities to develop and achieve key learning goals, through a variety of learning activities and settings" (Suskie, 2018, p. 67).

Our focus above has been on the psychology curriculum; however, research supports that students generally have difficulty learning statistical and research methods concepts across disciplines, which then creates common challenges for teachers of these courses (Garfield & Ben-Zvi, 2007; Lewthwaite & Nind, 2016). There are also commonalities in best teaching practices for these courses that apply across disciplines. In statistics, students learn best by being actively engaged in the classroom, practicing concepts and skills (with feedback), constructing meaning (not just memorizing concepts and algorithmically applying formulas), and confronting misunderstandings and errors in reasoning (Garfield & Ben-Zvi, 2007). In their review of the teaching of research methods across the social sciences, Wagner, Garner, and Kawulich (2011) found little literature on teaching research methods in general; however, they did find articles on teaching research methods within many specific social sciences disciplines. Thus, it seems there is a general concern across these disciplines for how to teach research methods effectively, even if there has not been much interdisciplinary conversation about shared challenges and concerns. More recently, Lewthwaite and Nind (2016) did find that some interdisciplinary discussion and research has begun, particularly around the value of active, reflective, and experiential learning opportunities. We argue a reasonable supposition is that the research methods sequence has the potential to support upper level coursework and promote high-impact practices across disciplines.

In this article, we describe efforts to increase student engagement and success in undergraduate research in the psychology curriculum at Indiana University Kokomo (hereafter IU Kokomo). We describe the research program and its challenges prior to 2012, when major changes were instituted to better address situational factors, to target several departmental learning outcomes, and to better scaffold students' development of research knowledge and skills. This includes a review of changes made to introduce research concepts and scientific inquiry early in the psychology curriculum and to provide students with a more in-depth research experience. We then discuss the current undergraduate research program, along with a generalized framework that could be applied across other disciplines. To assess student satisfaction with the structure of the undergraduate research sequence, in terms of their confidence and ability to understand and conduct research, we conducted a survey of current psychology majors and recent graduates of the program. The results of this survey, as well as instructor feedback and limited assessment data, are used to reflect on the efficacy of the current research program in our department and to provide suggestions for other programs considering changes to increase student research opportunities and program effectiveness.

IU Kokomo Case Study: A Brief History

The next two sections present a case study of the historical development and current structure of the research/inquiry program in the Psychology Department at IU Kokomo. Psychology faculty members developed this program as part of the degree requirements and available learning opportunities for psychology majors seeking a bachelor of arts (B.A.) or bachelor of science (B.S.) degree in psychology. IU Kokomo is a public regional university with an enrollment of approximately 3,100 students that offers B.A., B.S., and master of arts degree programs in north-central Indiana. The Psychology Department has nine full-time faculty. The undergraduate program serves about 140 majors and 170 minors. Approximately 35% of our psychology majors are first-generation college students.

In this section, we begin with a brief description of the program prior to fall 2012. This is followed by a review of the challenges faced and changes made that led to our current program. A note on terminology: Although there is significant overlap in common uses of the terms research and inquiry, research here refers specifically to the systematic empirical methods (e.g., experiments, surveys, observational methods) used within the discipline. Inquiry refers to any focused investigation and is used here to imply a broader collection of activities, which also includes student learning, information gathering, critical thinking, and questioning and exploration across a range of personal, professional, and academic (disciplinary) contexts.

The Pre-2012 Research/Inquiry Program

The psychology major requirements at IU Kokomo have gone through several iterations, but prior to 2012, the core courses in the research sequence were General Psychology (PSY P103), Methods of Experimental Psychology (PSY P211), Statistical Techniques (PSY K300), and Senior Seminar in Psychology (PSY P457). In General Psychology, students were introduced to scientific thinking and basic types of psychological research methods. They then further developed their critical thinking skills and learned about research methods more in depth in Methods of Experimental Psychology. In this methods course, students conducted a survey research project as a class, and each student proposed a hypothesis based on the data collected. The instructor then analyzed the data for the students, because the statistics course was not a prerequisite for the class, and students individually wrote research reports as the final paper. In Statistical Techniques, students learned how to conduct statistical analyses. Last, in Senior Seminar, students focused on a topic selected by the instructor (e.g., self-esteem, positive psychology), read more advanced scholarly literature, including empirical studies, and wrote a research proposal as the final paper in the class. Students could also elect to take a Supervised Research sequence (PSY P493/P494), where they developed their own research project, while working with a faculty member; they had to select between supervised research and psychological internship options (most chose the latter due to more practice-based interests).

Program Challenges

The pre-2012 program had several limitations, which faculty identified and discussed during program assessment meetings, summer "retreats" (where psychology faculty met to discuss broader curriculum and programmatic issues), and an external program review. Here we briefly outline six challenges identified during those discussions. The first three challenges relate directly to the research course sequence, whereas the last three address how the research sequence fits with additional program goals and components of the psychology major.

The first challenge identified was that the Methods of Experimental Psychology (PSY P211) course was bursting at the seams; we were just trying to do too much in this course. Course goals included reviewing a variety of research methods and designs commonly used in psychology as well as research ethics, while also developing students' skills in critical thinking, information literacy, conducting literature reviews, and writing in APA style. Students and faculty were overloaded and stressed out, due to the amount of material and the number of writing assignments. We had one shot at helping students learn these skills, as there was no upper level research course and many of our other upper level content courses (e.g., cognitive psychology, social psychology) did not have research methods as a prerequisite.

A second challenge we faced was that students typically took their only research methods course before taking statistics. A few students took these courses in reverse order or concurrently (due to scheduling needs), but the methods course instructors generally could not rely on students having an understanding of the role of descriptive and inferential statistics in quantitative research or their being familiar with specific statistical procedures. A challenge faculty confront when sequencing these two courses is that each course is needed to understand the other, and students really need to learn how statistics and (quantitative) research methods are interrelated. On the one hand, if students take statistics before research methods, they may lack an understanding of research necessary for them to grasp the role of statistics in research data analysis. On the other hand, if students take research methods before statistics, then, as we experienced, they lack basic tools for quantitative analysis in their research methods course.

The third challenge was related to the previous one, in that, given we taught research methods before statistics, students did not have a context for applying what they learned in statistics after completing that course. In the feedback received from students, several expressed concerns about a lack of statistical competence and confidence due to there not being opportunities for them to use statistics and apply what they learned in research. After the statistics class, there was no upper level methods course; most students did not elect the supervised research sequence (instead choosing the internship option), and the Senior Seminar required only a research proposal (not its implementation). Thus, students learned about research methods and statistics separately, but these were not integrated or applied in later coursework.

A fourth challenge was related to our students having diverse interests, career goals, and plans after graduation (e.g., whether they planned to attend graduate school). Our research program was mostly a one-size-fits-all approach that did not accommodate these differences well (a previous attempt to develop a research track failed to attract enough students to be viable). For those not planning to continue on to graduate school or who are pursuing more practical interests, the most important research-related goals are for them to have a basic understanding of research and to develop as good research "consumers" who can comprehend, critically evaluate, and apply research findings. In contrast, for those planning to go to graduate school, their undergraduate program should ideally also provide them with initial opportunities to be engaged as research "producers." These students would more likely benefit from an upper level research methods class as well as opportunities to develop their own research projects. Although the supervised research sequence was meant to address the latter, few students selected this option.

The fifth challenge was separate from the research sequence but was related to issues of personal and career-related inquiry. Through our program assessment efforts and review of the APA undergraduate program guidelines, we had earlier identified several learning outcomes that were not adequately addressed in any of our required courses. These were related to students' personal growth (e.g., student learning and success, communication skills, personal ethics) and career development (e.g., knowledge of careers, personal career exploration and planning). Moreover, in our campus's move from reliance on faculty to reliance on general professional advisors, issues arose related to how we could best recruit students into the major and provide students with information about program faculty, course requirements, and learning opportunities. In 2004, we had developed a one-credit course called Introduction to the Psychology Major (PSY P199), required of psychology majors, to address these personal and career outcomes as well as critical thinking skills (to off-load some of this from the research methods course). However, students often thought this new course required too much work for just one credit, and many did not take it seriously as an extra "add-on" (not counting as a full class, it added to an already heavy course load for both students and faculty).

The final challenge also concerned our broader program structure and goals. In addition to Senior Seminar, in 2008 we added History and Systems of Psychology (PSY P459) as a second required senior course. In addition to the traditional "history and systems" content, this course sought to provide a senior capstone experience for psychology majors that could help them review and integrate ideas from previous courses and "dig deeper" into foundational issues and controversies within the field. Through discussions of historical and modern systems of thought in psychology, the course also aimed to further develop psychology majors' critical thinking and writing skills. Although as faculty we thought this was a valuable addition to the curriculum, it also increased the number of required courses for our majors. In addition, an external program reviewer noted that we were fairly unique in requiring two different senior capstone courses and recommended we choose just one.

Program Changes

The new research/inquiry program introduced in fall 2012 was designed to address the above challenges. It aimed to provide students with a broader, deeper, and more integrated understanding of research methods and to promote the value of an inquiry orientation in their roles as emerging student scholars, future professionals, and lifelong learners. In this section, we briefly outline key revisions made in creating the new program. Specific components are discussed in greater detail in the next section, which outlines the six levels of our current program.

First, a new course, Introduction to Psychological Inquiry (PSY P259), was created. This course now focuses on developing students' knowledge and skills for personal inquiry (as students and lifelong learners) and building a foundation for scholarly inquiry within psychology (as student researchers and future professionals). The former includes topics such as introduction to the psychology major, strategies for self-regulated learning, and career exploration. The latter includes emphasis on critical thinking, writing a literature review in APA style, and developing an understanding of basic research methods concepts. This new course incorporated many elements of the one-credit Introduction to the Psychology Major course (which was eliminated) and replaced the previous lower level research methods (PSY P211) requirement.

Second, a new upper level research methods course, Experimental Psychology (PSY P355), was added as a requirement for all psychology majors. Statistical Techniques (PSY K300) was a prerequisite for this course. Thus, this addressed several challenges above. With Introduction to Psychological Inquiry (PSY P259) now providing an introduction to research methods and focusing on critical thinking and APA-style writing, this upper level course was then able to offer a more in-depth look at various research methods (especially important to prepare those going to graduate school). Moreover, students now took statistics between these two courses (creating a "stats sandwich"). PSY P259 provided students with a basic understanding of research and the general role of statistics in research, prior to their taking the statistics course. After the statistics course, students then had the statistical tools to apply in the upper level research methods class (including knowledge of SPSS, a commonly used computerized statistical analysis program). This enabled students to better understand the relationships between statistics and research methods, while providing them opportunities to apply statistical knowledge and skills in the context of research design and data analysis. Recently, we expanded the upper level Experimental Psychology course to four credits, adding a lab component to provide additional opportunities for application and guided practice.

Third, around the time we were revising the research/inquiry program, our campus was also expanding degree options for students through the development of B.S. degrees, which were primarily intended to provide students options with reduced general education requirements but more coursework within their majors. In psychology, we retained the B.A. degree (now targeted mostly to those seeking a broader liberal arts education) but added two B.S. degree tracks. The B.S. General track required more coursework in the natural sciences, especially biology and/or chemistry, and was targeted more to students who were transferring in from nursing or other natural science fields or were pursuing careers in physical therapy, occupational therapy, medicine, or neuroscience. The B.S. Psychological track, in contrast, required more upper level psychology courses and was developed specifically for students planning to pursue graduate school in psychology. Whereas the B.A. and B.S. General track degrees continued to give students an option of the two-semester supervised research sequence (PSY P493/P494) or an internship (now preceded by a class on helping skills and ethics), those in the B.S. Psychological track were required to complete the supervised research sequence. Thus, those planning on attending graduate school in psychology had further opportunities to explore their own research interests and develop their skills as both research consumers and producers through work on their own research projects.

Fourth, as recommended by our external program reviewer, we eliminated one of our two senior capstone courses, specifically the Senior Seminar course. We chose to retain History and Systems as our senior capstone, in part because of our belief in its importance (see course goals described above), but also because we now felt comfortable dropping Senior Seminar given the other changes made to the research/inquiry curriculum. For those in the B.A. and B.S. General tracks, the upper level research methods course now provided sufficient depth to prepare them to be good consumers and appliers of psychological research (these students still retained the option of taking the supervised research sequence as electives). Those in the B.S. Psychological track were now required to take the supervised research sequence, ensuring they would get practice not only developing a research proposal but also implementing it by conducting their proposed project. Thus, we believed the former group no longer needed Senior Seminar and the latter group would now get a more in-depth and authentic research experience.

Finally, we sought to better integrate these research/inquiry components (with greater attention to connections between courses) and create additional experiential opportunities for students beyond the classroom. This was facilitated by the development of an Institute for Undergraduate Research in Psychology, with a coordinator who was given one course release per year to provide time for planning and overall coordination of the research/inquiry components. Further, the Psychology Department was able to expand research-related learning opportunities available to students through coordination and funding provided by a campus-wide program promoting student engagement and experiential learning. This program, called KEY (the Kokomo Experience and You), is discussed further below.

IU Kokomo Case Study: The Current Program

The program changes discussed above resulted in our current research/inquiry program for psychology majors at IU Kokomo. This section provides an overview of our program goals and outcomes, followed by the introduction of a six-level framework for scaffolding students' research/inquiry development and a description of each level. Although the department has been engaged in on-going discussions of program goals, the curriculum, and their implementation, and the ideas for program change developed gradually through these discussions, most changes in program requirements focused on here were implemented together, beginning with students declaring psychology as a major in the fall 2012 semester. Minor changes that were made to the program after 2012 are discussed where appropriate.

Program Goals and Outcomes

The IU Kokomo Psychology Department faculty developed goals and outcomes for the psychology major, based on a report by a committee of the APA's education division (APA, 2007). That report outlined a set of 10 goals that are important for undergraduate psychology programs. The psychology faculty at IU Kokomo selected and/or modified a subset of eight of those goals that most directly applied to the psychology program's mission. The outcomes from our program goals that most relate to research and inquiry are listed in Appendix 1.

Program Research/Inquiry Components

The research program for psychology majors at IU Kokomo consists of six levels (see Table 1). Each level provides support or scaffolding for the next, moving students from first exposure to basic research concepts, to more advanced concepts and skills, and finally to their application in meaningful experiential contexts.

Table 1. Indiana University Kokomo Psychology Department research program levels.

Level	Course	Description
1	General Psychology (PSY P103)	Introductory course (survey and first exposure to disciplinary content areas and research methods)
2	Introduction to Psychological Inquiry (PSY P259)	Introduction to disciplinary inquiry (e.g., the major/faculty, careers, critical thinking, research)
3	Statistical Techniques (PSY K300)	Statistics (or other analytic tools for nonquantitative research)
4	Experimental Psychology (PSY P355)	Research methods course (upper level course on discipline-specific research methods)
5[a]	Supervised Research I/II (PSY P493/P494)	Supervised research (independent student project)
6[a]	Experiential (KEY) opportunities	Experiential Opportunities (e.g., conference and presentation opportunities)

Note. The described topics are applicable across disciplines. KEY = Kokomo Experience and You.
[a]Levels 5 and 6 are available opportunities but not requirements for all psychology majors.

The psychology program has been able to maintain a high level of quality and rigor in our courses because we have been intentional about keeping the courses as small as possible. As it is a very work-intensive course, Introduction to Psychological Inquiry is always held to 25 or fewer students per section each term. This allows instructors to provide more directed attention to student learning goals and interests as well as more substantive feedback on their writing assignments. The Statistical Techniques course typically enrolls between 20 and 35 students per section. It is rarely offered online but has been previously capped at 25 students when it has been offered in that format. Recently, the course cap for face-to-face courses was lowered to 32, so no more than 32 students will be in a course moving forward. Experimental Psychology is always the smallest course, with a limit of 20 students in both the lecture and lab components. While not the subject of the current analysis, our General Psychology courses had been previously offered with course caps of 45 students.

Level 1: General Psychology (PSY P103). This is a one-semester introduction to the field of psychology. As a survey course, students are provided an overview of basic concepts across a wide range of topics or subdisciplines (e.g., research methods, the brain and nervous system, sensation and perception, memory, learning, thinking and intelligence, human life span development, personality, social psychology, and psychological disorders and treatment). This is the first course in psychology taken by psychology majors. However, the vast majority of students in this course are not psychology majors, as it is required by many other majors (e.g., nursing, business), counts toward campus-wide general education requirements (e.g., for social and behavior science and ethically responsible citizenship), and is a popular elective for students.

With regard to research and inquiry, General Psychology provides the first exposure to research concepts and critical thinking skills within the major. Instructors spend 1 to 2 weeks specifically focused on introductory topics relating to critical thinking and research methods. These concepts and skills are then reinforced throughout the semester, as they are applied to various content areas within psychology. This provides a foundation for all subsequent psychology courses. Learning outcomes, shared across all sections of the course, are organized in terms of four broad areas: (a) understanding psychology as a discipline; (b) basic psychological literacy; (c) methods of inquiry; and (d) critical thinking and application of psychology. Specific learning outcomes relating to methods of inquiry include the following: Explain the role of research methods in psychology as a science; demonstrate basic psychological literacy in research methods; evaluate appropriateness of conclusions derived from psychological research; and recognize need for ethical standards/actions in psychological research. Related critical-thinking learning outcomes include questioning unsupported claims, identifying potential biases, and recognizing psychological issues that have varying viewpoints.

Level 2: Introduction to Psychological Inquiry (PSY P259). This course aims to develop students' skills as learners, inquirers, and consumers and producers of research in psychology. Specifically, the course addresses three broad areas:

- Psychological contexts of inquiry (understanding psychology as a discipline and a major)
- Learning and inquiry orientation (developing students as self-regulated learners and critical inquirers)
- Foundations of research methods (learning basic research concepts and skills).

The course provides an overview of basic inquiry processes and psychology as an area of inquiry. It explores two interrelated strands that are woven throughout the course. About half of the course emphasizes inquiry from a more personal and student perspective, including discussion of the psychology major, careers in psychology, and concepts and strategies for developing as a self-regulated learner and critical and reflective inquirer. The other half of the course emphasizes scientific inquiry within the discipline of psychology, with an emphasis on critical thinking skills used for evaluating claims people make relating to psychology and an overview of research process, methods, and design. Students have the opportunity to develop and apply learning, inquiry, critical thinking, and writing skills throughout the course. Reflection journals, assignments, and inquiry projects help students reflect on their own goals and skills and learn about careers in psychology. A major assignment for the course is the completion of a literature review on a psychology-related topic, with an emphasis on identifying scholarly sources, integrating ideas in a literature review paper, and writing in APA style.

This course was designed for psychology majors to provide basic knowledge and skills relating to psychological inquiry, critical thinking, and research methods that will be further developed in statistics, experimental psychology, and, for some, supervised research. After successful completion of this course, students should also be better able to understand and think critically about research studies in other psychology courses (as well as those from other disciplines) and claims made in everyday contexts (e.g., in the media, by family and friends, by politicians). The course topic sequence as organized recently (in spring 2020) is outlined in Appendix 2. Although there are some differences in course structure, emphasis, and assignments across the four faculty who have taught this course, there is significant overlap with respect to the above course description and these course topics.

Level 3: Statistical Techniques (PSY K300). This course aims to provide students with an understanding of basic descriptive and inferential statistics. Topics include displaying data with tables and graphs, measures of center and spread, correlation, normal distributions, probability, sampling distributions, confidence intervals, basic tests of significance (z and t tests for one and two samples), and an introduction to more advanced procedures such as analysis of variance (ANOVA), the chi-square test, and regression. In addition to this fairly standard list of course topics, students also learn the statistical computer program SPSS. The emphasis is on understanding concepts (over number crunching) and applying concepts and skills to data analysis using SPSS.

Level 4: Experimental Psychology (PSY P355). The main goals of this course are for students to learn more about research methods in psychology and to integrate the use of statistical techniques with research methods. Students learn about the basic methods in psychological research, particularly surveys, correlations, and experiments. They learn about validity and ethics in research as well. The experiential component of this class is that students conduct experiments with a small group of their classmates. To allow students to have a more authentic experience in research, each group selects a topic to perform an experiment on, using vignettes to manipulate their independent variables. Students complete training to work with human participants through the Collaborative Institutional Training Initiative (CITI). They then complete the Institutional Review Board forms for course credit. Data are collected using Amazon MTurk, and students select and perform the appropriate statistical analyses to test their hypotheses. This class was designed for students to have the opportunity to implement the skills learned in Statistical Techniques, because we find that unless students have practice with those skills, they show a decreased ability to remember and use SPSS in later research projects.

For the first 3 years that we offered this class, we offered it as a three-credit class. As the class evolved, we found that students did not have enough time to complete the group research project in addition to learning the content and skills required for the class. Thus, in fall 2018, we added a one-credit lab to the class. The lab was scheduled in a computer classroom so that students could have access to programs for conducting their research online, including Qualtrics and SPSS. The lab time focuses on practicing SPSS as well as completing group work to progress in their research project.

The final product is an individually written APA-style research report. For students who opt to complete their experiential requirement in psychology through an internship, this will likely be their final experience in conducting research; other students use this course in preparation to complete their own independent research project in Supervised Research (PSY P493/P494).

Level 5: Supervised Research I and II (PSY P493/P494). Undergraduate majors are required to complete one of two tracks: an internship track or the research track. In the research track, students complete Supervised Research I and II, in which they conduct an independent research project under the supervision of a psychology faculty member. One of the faculty members in the Psychology Department acts as the Institute for Undergraduate Research in Psychology coordinator, who provides support and guidance for undergraduate research. Students who plan to conduct supervised research are encouraged to meet with the coordinator to determine which faculty member would be the best fit to supervise their research program, based on each faculty member's expertise in a particular subject area and/or research methodology. The student then selects a faculty mentor to work with on an individual basis, providing a personal connection between the student and that faculty member.

Students typically take Supervised Research I following the completion of Experimental Psychology, but some students enroll in these courses concurrently. In Supervised Research I, students complete a literature review in an area of interest and design a study. If their certification has lapsed, students update their CITI training. With faculty assistance, students also complete a research proposal to submit to the Institutional Review Board for study approval; this is another skill students gain experience with in Experimental Psychology. If students plan to work with animals, they must complete the applicable CITI training and, with faculty assistance, complete a research proposal to submit to the Institutional Animal Care and Use Committee. Students often employ survey or experimental designs, conducted with online participants, but some conduct in-person studies. In Supervised Research II, they typically collect and analyze their data, complete a research report in APA style, and often present their results at the campus, university, regional, or national level (discussed more in Level 6, below).

Level 6: Experiential (KEY) opportunities. The KEY program was launched in fall 2016 to support and promote experiential learning opportunities at all levels of the undergraduate curriculum. The KEY program supports experiential learning on campus, but it also facilitates domestic and international trips for groups of students.

As part of the psychology program at IU Kokomo, students are encouraged to attend conferences to learn about how research is conducted and disseminated and to encourage scientific inquiry. These efforts are typically under the purview of Introduction to Psychological Inquiry (Level 2) or Psychology Club. Students often present their own results from their independent research projects (Level 5) publicly. Presentation options include IU Kokomo's annual Undergraduate Research Symposium (campus level), Indiana University's annual Undergraduate Research Conference (university level), other undergraduate and professional conferences in Indiana, regional conferences such as the annual conference held by the Midwestern Psychological Association, and national conferences such as the annual conferences of the APA and the Society for Personality and Social Psychology. Conference attendance is encouraged for psychology students at any level, but it may be especially useful earlier in the curriculum because of the example and encouragement it provides. Approximately 20 to 30 psychology majors and minors attend conferences each year.

In an effort to cultivate a departmental environment in which students have regular exposure to psychological research, we also began holding monthly research meetings at the department level in fall 2019. These research meetings are advertised to psychology courses and the Psychology Club, and they provide a regular opportunity to learn about research for students who may not be able to travel to conferences. Thus far, faculty members have given presentations on their own research (either completed or in progress), but students are invited and encouraged to present their own research as well. Through the conferences and research presentations, we provide greater opportunities for faculty and student interactions outside of the classroom.

Summary and Generalizability Across Disciplines

As students move through these six levels, they advance their understanding and skills relating to research and inquiry. Each level provides scaffolding for more advanced understanding and skills at higher levels. Although we have described the details specific to our psychology program, the general approach is applicable across many disciplines (see Table 1). The framework is general enough that it can be easily adapted to meet the needs of different disciplines, program goals, and institutional contexts.

Levels 1 and 2 introduce students to research and inquiry while providing a basic foundation for future learning. The key features of our framework at these levels are (a) the inclusion of lower level courses that provide both an introductory survey of the content of the field (likely open to both majors and non-majors) and an introduction to disciplinary inquiry (for majors and possibly minors) and (b) a broad emphasis on inquiry, which includes personal, professional, and scholarly inquiry relating to the discipline. Adaptations, however, could be made to accommodate a two-course introductory sequence (for Level 1) or different emphases in the introduction to disciplinary inquiry course (for Level 2).

Levels 3 and 4 provide more in-depth understanding and skills specific to research within the discipline. For disciplines where quantitative research is important, statistics and upper level research methods courses are likely appropriate, though there will be variation in emphasis across disciplines. For example, ANOVA and experimental designs may get more attention in psychology, whereas regression and observational or quasi-experimental designs may get more emphasis in sociology or business. Some programs may also combine statistics and research methods into a two-course integrated sequence. Disciplines with more emphasis on nonquantitative research could replace statistics with courses such as qualitative inquiry, program evaluation, or various forms of critical or theoretical analysis. Of course, for a broader focus, students could take courses in both quantitative and nonquantitative methods. For these middle levels, key features of our framework to be retained are (a) the integration of research tools with research methods (for us, statistics "sandwiched" between the introduction to disciplinary inquiry at Level 2 and the more advanced research methods course at Level 4) and (b) the connections of these middle levels to the lower and higher levels (building on the introductory courses and providing tools to be applied in subsequent research activities).

Finally, Levels 5 and 6 provide opportunities for students to apply what they have learned, in more individualized supervised research and experiential opportunities. These activities enable students to begin to develop their own areas of interest and research ideas and become engaged as consumers and producers of disciplinary research. In our program at IU Kokomo, although these are not required of all students, we have sought to make them available to all our majors and promote them as valuable components of their undergraduate experience that can better prepare them for graduate school (if applicable) and their careers. Programs can adapt how supervised research is offered (e.g., for larger schools, meeting in research groups may be not only possible but necessary) and what experiential opportunities are available (e.g., on-campus presentations, experiential learning activities, opportunities for students to attend or present at conferences). A faculty member (with a course release) who oversees these activities and dependable administrative support and funding sources are helpful to ensure high-quality opportunities can be provided consistently for students.

Assessment of Student Experiences in the Research Program

Method and Design

To measure the effectiveness of the changes to the research program, faculty developed a survey to be given to current and former students that focused on the required coursework and experiential learning activities. The primary areas of interest were (a) whether students perceived the required course or activity as effective in developing a critical skill for the research process and (b) whether the required course or activity effectively increased their confidence in conducting research. Questions were drafted that addressed the individual courses as well as student attendance at one of several research conferences throughout their academic careers.

We sought research approval through the university Institutional Review Board, which was received in January 2020. After approval was obtained, we consulted with the Office of Institutional Research and Office of Admissions to receive email-only contact information regarding current psychology majors and psychology graduates from 2013 to the most recent graduating class (2019). Less recent graduates would not have experienced some of the changes made to the program in 2012. As part of the approval process, an email script was sent to the collected list of current and former students. A mail merge list was loaded into Qualtrics, which was used to generate the survey. Students received the survey directly from Qualtrics' distribution system at three points in time over the course of 6 weeks.

From the original list of 220 email contacts, 75 students responded. Two respondents were eliminated from the final pool, leaving a final sample of N = 73. One was eliminated because they did not complete the entire survey. The other response was eliminated because the student indicated they completed the majority of their degree requirements at a different campus before transferring into our program to complete their degree. No students in any of the authors' current courses were directly solicited for participation in the survey to reduce any suggestion of coerced participation.

Demographic Data

The survey respondents were evenly split between graduates and current students. Slightly more than half (37) were graduates, with most of this group having graduated between fall 2013 and summer 2018. Other information about the class standing of the participants is listed in Table 2. The respondents were overwhelmingly female (64), which reflects enrollment in our major in general. We did not ask questions about their race, ethnicity, or sexual identity because diverse students are not heavily represented in the program and responses to these demographic questions could have easily identified them.

Table 2. Survey respondents' class standing.

Class	Frequency
Sophomore	16
Junior	9
Senior	11
Recent graduate (fall 2018 to fall 2019)	14
Slightly older graduate (fall 2013 to summer 2018)	23
Total	73

Introduction to Psychological Inquiry (PSY P259)

Fifty-six respondents had completed Introduction to Psychological Inquiry. Respondents who had not completed the course could be currently enrolled, could be scheduled to take the course in a future semester, could have transferred in with an equivalent course, or could have progressed through the research sequence before the course was introduced in 2012. As shown in Table 3, fifty-four (96%) of the respondents found the course slightly effective or better in helping them develop basic research skills. All the respondents (56) reported that the course was slightly effective or better in helping them develop critical thinking skills. A subset of that group (38) responded to a question regarding the preparation they received for the next course of the research sequence. Twenty-six (68%) of those respondents felt the course prepared them well for Experimental Psychology (PSY P355). This is important, as Experimental Psychology is research intensive and requires students to apply the initial knowledge gained in Introduction to Psychological Inquiry. There is still room to improve so that more students feel prepared for the experimental methods course, and discussions are underway about potential modifications to the course to increase student confidence and understanding of research methods.

Table 3. Student-perceived effectiveness of courses in achieving targeted goals.

Course (and targeted goal)	Very effective	Moderately effective	Slightly effective	Not effective at all	Total
P259 (research skills)	23 (41%)	22 (39%)	9 (16%)	2 (4%)	56
K300 (statistical literacy)	25 (52%)	11 (23%)	7 (15%)	5 (10%)	48
P355 (research skills)	17 (45%)	11 (29%)	6 (16%)	4 (11%)	38

Statistical Techniques (PSY K300)

Like many programs, the statistics course has the most variability in how students perceive its usefulness. However, on a positive note, the overwhelming majority of respondents (43; 90%) thought the course was slightly effective or better in helping them develop statistical literacy (see Table 3). Students are exposed to real-world applications of data reporting and the ways in which statistics influences their daily lives. This allows them to move beyond learning statistics as abstract concepts and apply them to real-life data. In addition to the previous findings, two thirds of our respondents thought the statistics course helped prepare them a moderate amount or better for the next course in the research sequence (Experimental Psychology), and the remaining third thought it prepared them a little. While students are introduced to statistical analyses and the research process in this course, application of what they have learned mostly occurs in Experimental Psychology.

Experimental Psychology (PSY P355)

Thirty-eight of the 73 respondents had completed Experimental Psychology. As with Introduction to Psychological Inquiry, respondents who had not completed the course could have been currently enrolled, could have been scheduled to take the course in a future semester, or could have progressed through the research program before the course was introduced in 2012. Thirty-four (89%) thought the course was at least slightly effective in helping them develop basic research skills (see Table 3). Twenty-three students (61%) indicated they felt the course helped prepare them to conduct independent research. Those who complete independent research are exposed to CITI training, work through the Institutional Review Board process, draft their own research questions, and analyze data. They typically are able to work through the initial portions of the independent research sequence quite easily because they can draw on their previous training. Twenty-two completed the course with a lab component—an addition beginning in fall 2018—and the majority (17; 77%) thought the lab was a beneficial component of the course. The lab component increases the amount of time students have to work with data, independently and in small groups, as well as to reflect on good and bad research design and explore what they could have done to improve their studies.

Supervised Research I and II (PSY P493/P494)

The independent research courses are completed by a subset of psychology majors. Of the 73 respondents, only 18 had completed both semesters of supervised research at the time of the survey. Not surprisingly, of those who had completed this set of courses, the vast majority (17; 94%) indicated they were moderately confident or very confident in their research skills. One respondent indicated they were not confident, but there was not a follow-up question, so there is no explanation as to why they chose that option.

Experiential Opportunities

One-third (24) of all respondents had attended at least one research conference during their time as an undergraduate student. Of those who did, two-thirds (18) said attending increased their confidence in conducting research at least moderately. All respondents who attended at least one research conference found it to be a valuable educational experience.

Research Program

When asked about the psychology research program as a whole, a majority of respondents indicated that the program developed their understanding of research in a supportive way (59; 81%), that they felt moderately confident or better in their ability to conduct psychological research (51; 70%), and that they felt moderately confident or better in their ability to read and understand psychological research (63; 86%).

Program Assessment Data

In addition to the survey data, we also have limited assessment data on student learning of research-related learning outcomes. Instructors assess such learning within courses, but the psychology faculty could do more to assess broader trends and longer term retention of knowledge and skills at the program level. In the History and Systems senior capstone course, senior psychology majors typically take the Area Concentration Achievement Test for psychology. This is a standardized test assessing knowledge in 10 specific areas of psychology that compares our students to thousands of other senior psychology majors across the country. Relevant here are the subtests for statistics and experimental design. Our goal has been to be above the 50^{th} percentile for group performance. Whereas over the 5-year span from 2013 to 2018 we consistently scored at or above the 50^{th} percentile in statistics (ranging from the 49^{th} to the 56^{th} percentile), scores for experimental design have been consistently below this benchmark (ranging from the 32^{nd} to the 42^{nd} percentile). We hope expanding the Experimental Psychology course to four credits with the computer lab provides students extra time for concept application and guided practice and can help increase these scores.

Conclusion

Overall, the respondents were pleased with the sequencing of courses and the support they received throughout the program to develop various skills. Notably, the vast majority of respondents thought Introduction to Psychological Inquiry (PSY P259) and the Supervised Research sequence (PSY P493/P494) were helpful in developing critical thinking and/or research skills. These are important skills within the major but also for daily living, when misinformation is often placed alongside factual data. Individuals need to know how to process and choose the best sources of information. A great majority felt that Statistical Techniques (PSY K300) and Experimental Psychology (PSY P355) were helpful in building knowledge and skills, and the majority thought these courses prepared them well for the next step in the research program. Many students find both courses difficult, but as reflected in the survey data, they understand and appreciate the role of each course in the research program in developing their understanding of research and the role it plays in psychology. Additionally, a great majority of respondents felt the research program as a whole was successful in developing their understanding of research and increasing their confidence in understanding and conducting research.

Anecdotally, our graduates have inform us of how much more prepared they are than their graduate school colleagues because of the research courses required in our program. This preparation and opportunity for experiential learning has led to a number of them receiving admissions into programs ranging from counseling to organizational psychology to law school and fully funded doctoral programs. Finally, as was noted previously, students who attend research conferences find them valuable and learn a great deal from them. We will continue to seek funding through internal and external sources to increase attendance at local, regional, and national conferences and to provide conference presentation support for students to present their own research. These experiences allow our students, who are often first-generation students, to see new opportunities on personal and professional levels, as well as increase their confidence in their ability to conquer new challenges.

As a high-impact practice, undergraduate research provides multifaceted value. Even in students who do not conduct independent research or pursue research-focused graduate study, the undergraduate research curriculum can develop collaborative skills and facilitate critical thinking and careful consumption of information. However, courses designed to teach students these skills (such as statistics and research methods) can elicit anxiety in students (Onwuegbuzie & Wilson, 2003; Papanastasiou & Zemblyas, 2008), which is associated with lower performance in those same courses (Freng, 2020; Onwuegbuzie & Wilson, 2003; Papanastasiou & Zemblyas, 2008). Student confidence in these subjects may be increased by providing ample scaffolding and designing a curriculum that provides multiple opportunities to practice and apply concepts across courses. Additionally, through two-semester supervised research projects, students develop one-on-one relationships with their faculty mentors (Kuh, Kinzie, Schuh, & Whitt, 2010).

Studies have shown that students' beliefs about psychology as a science are associated with better grades in psychology courses (Friedrich, 1996) and performance on the Psychology Assessment Test (Freng, 2020). Research suggests that creating an early understanding and appreciation of research methods and scientific inquiry will result in better performance in upper level courses (Freng, 2020). We believe that curricular design is important for achieving these goals, but opportunities for undergraduates to see research in practice, including attending conferences and research talks, may also be valuable learning experiences. The performance gains of early understanding of research methods may have far-reaching implications: Not only might students have a more intellectually fulfilling academic experience, but better grades may improve graduate school and career opportunities.

Limitations

We must acknowledge several limitations of this case study and assessment. A major issue is the limited assessment of student learning outcomes. We do use program assessment results to guide curriculum design, and we recommend the collection and use of assessment data in understanding the role of high-impact practices such as undergraduate research in programs. We plan to revise our program assessment to more systematically evaluate these outcomes. Our survey data on student perceptions support our sequencing and course design, but more data collection is needed. Additionally, our assessment compares graduates in psychology to current students, and these groups differ not only on their current enrollment status, but also on the recency of their course experiences and their ability to use hindsight in evaluating our program. Nonetheless, these groups showed similar and expected patterns in their attitudes toward the research sequence in psychology.

Remaining Challenges and Future Directions

In reflecting on the research/inquiry program, psychology faculty have generally been satisfied that program changes have addressed the initial challenges we outlined above. However, we continue to engage in assessment, reflection, and dialogue in efforts to increase student learning. Based on observations of student performance, we have identified three areas for further curricular improvements. First, although writing literature reviews in APA style is emphasized in a required writing course, the Introduction to Psychological Inquiry and Experimental Psychology courses, and several other upper level courses, some students still struggle in this area. We have recently been collaborating with faculty in English to provide students with more background in APA style and literature reviews. Second, even when students have successfully learned research methods and statistics concepts, they often have difficulty identifying which statistical procedures are appropriate for which types of questions (i.e., knowing "when to do what"). Third, although students may learn to be able to think critically when asked to do so in class, these skills do not always generalize as a critical inquiry orientation to other classes or beyond academic contexts. It should be noted that we see a similar lack of critical thinking and evidence-based reasoning in a surprisingly large proportion of the general public. However, we seek to continue to promote these skills, essential for students' success as professionals and for responsible citizenship in a pluralistic democracy.

Recommendations

In closing, we have several recommendations for other programs wishing to examine and revise their undergraduate research sequence. First, in the "Summary and Generalizability Across Disciplines" section, we provide a framework with some structure but enough flexibility to accommodate undergraduate research in a variety of disciplines (though particularly focused on more empirical methods). Mapping these levels onto your discipline and curriculum should help determine where your program may contain gaps to be addressed in program development. For example, we determined that students needed additional time for guided research development, and thus we added a lab component to our upper level methods course. A coordinator for undergraduate research can take the lead in identifying and revising the curriculum to enhance student learning and self-efficacy in the research process.

Additionally, we recommend developing a plan to request funding, and to seek out funding from a variety of sources. In psychology, the costs to perform research vary widely, but they may include payment for participants, access to materials such as tests and software, technology costs, and travel to conferences or field sites. In other disciplines, research may be more or less expensive, but it is unlikely to be free. To secure necessary funding, we have had to be willing to apply for funding from a wide variety of sources (mostly internal to the university). In addition to the Office of Academic Affairs, some of our travel funding has come from the Office of Student Affairs and from our campus's funding for experiential learning, the KEY program. Although your institution may not have these particular types of funding available, being able to connect undergraduate research to your institution's mission and goals can enable you to demonstrate the value of undergraduate research and better advocate for needed financial and administrative support.

Developing a culture of research takes time, but it can be encouraged by offering regular and flexible opportunities for students to participate in research and attend conferences. In this regard, it is important to involve as many students as possible. Students may not be able to afford the time and money needed to travel to a research conference, but they may go to an on-campus presentation by a faculty member or advanced undergraduate student, particularly if the presentation can be incorporated into a class assignment. We have also found that involving students earlier in their college careers can help them get interested in or even excited about research. When we added a day trip to an undergraduate research conference as an option in our lower level inquiry class, students reported being less intimidated by the research process. Trips to conferences also provide students with opportunities to connect with other students and faculty outside of the classroom. Faculty and upper level students expressing their excitement about conducting and learning about research can enhance student interest in undergraduate research as well. Not only does this model how most faculty feel about research, but it can lead to greater connection between faculty and students, which is an outcome connected to greater student success (Kuh et al., 2010). While your institution will differ in the particulars from our experience, engaging in a thoughtful evaluation of your research program can help maximize student learning and success in relation to research and inquiry knowledge and skills.

Acknowledgments

We acknowledge the efforts of current and former faculty in the Department of Psychology who contributed to the development of the psychology curriculum. Special recognition to former department chair, Dr. Christina Downey, who guided the program through its initial changes and was instrumental in developing the Experimental Psychology course. Additionally, we appreciate the support of IU Kokomo Office of Academic Affairs and the KEY program.

Appendix

Appendix 1. IU Kokomo Research-Related Program Goals and Learning Outcomes.

Goal 1: Knowledge Base

- Demonstrate understanding of basic terminology relating to research methods.
- Demonstrate basic psychological literacy in statistics.

Goal 2: Research Methods

- Explain the role of research in psychology.
- Demonstrate understanding of basic terminology relating to research methods.
- Place research in context of earlier work.
- Evaluate appropriateness of conclusions derived from psychological research.
- Design basic studies to address psychological questions.

Goal 3: Critical Thinking

- Question unsupported claims.
- Recognize psychological issues that have varying viewpoints.
- Formulate one's own viewpoint.
- Recognize alternative viewpoints.
- Evaluate quality of supporting evidence.
- Describe implications and consequences that result from proposed conclusions.

Goal 5: Ethics

- Recognize necessity of having ethical standards/acting ethically.
- Understand what it means to be ethical in writing.
- Understand what it means to be ethical in research.
- Apply ethical standards in either research or practice.

Goal 6: Writing

- Communicate ideas effectively.
- Write an effective literature review.
- Use APA style documentation that is appropriate to the assignment.
- Use APA style formatting that is appropriate to the assignment.

Goal 7: Quantitative Literacy

- Evaluate appropriateness of conclusions derived from psychological research.

- Select appropriate statistics.
- Conduct statistical analyses.
- Interpret statistical results.
- Decide how results should be presented.

Goal 8: Career Planning and Development [related to broader personal and career inquiry]
- Demonstrate basic knowledge of careers in psychology.
- Demonstrate understanding of careers in psychology.
- Evaluate personal suitability for careers of interest.
- Develop a personal plan that addresses discrepancies and next steps.

Appendix 2. Introduction to Psychological Inquiry (PSY P259) Curriculum (Spring 2020).

Week	Topic	Brief description
1	Introduction to Psychological Inquiry	Introduction to the general inquiry process; psychological subdisciplines and perspectives
2	Characteristics of Scientific Inquiry	Characteristics of scientific inquiry and theories; falsifiability and measurement (reliability, validity)
3	The Psychology Major & Careers	Psychology major/minor requirements; careers in psychology; student subdisciplines poster session
4	Learning Strategies for Academic Success	Study skills and effective learning strategies; growth mindset (Dweck, 2006)
5	Descriptive & Correlational Research	Descriptive research (e.g., naturalistic observation, case studies, surveys); correlational research
6	Analyzing Qualitative & Quantitative Data	Types of data and variables; summarizing data with narratives, tables, graphs, and descriptive statistics.
7	Experimental Research	Characteristics of experiments; internal and external validity; interaction and converging evidence
8	"Meet the Faculty"/Making the Most of Your Education	"Meet the faculty" days; taking an active student role; considering graduate school
9	Evaluating Research Articles	Review of types of research, claims, and validity; evaluating research articles; research ethics
10	Confronting Myths & Pseudoscience	Pseudoscience and myths (causes and impact); critiquing common myths in psychology
11	Information Literacy: Finding Credible Sources	Finding scholarly sources; using library databases (e.g., PsycInfo); identifying credible sources
12	Career Presentations	Student presentations of psychology-related careers; student resume writing/update
13	Writing Literature Reviews & APA Style	Writing literature reviews; introduction to APA style; student literature search and annotated bibliographies
14	Sampling, Bias, & Probabilistic Reasoning	Sampling and sampling bias; probabilistic reasoning; role of inferential statistics
15	Lifelong Learning and Inquiry	Mindset revisited; importance of lifelong learning and inquiry; sharing student learning interests
16	Conclusion	Student literature review papers due; final exam

Note. APA = American Psychological Association.

References

American Psychological Association. (2007). *APA guidelines for the undergraduate psychology major.* Retrieved from http://teachpsych.org/Resources/Documents/otrp/resources/apapsymajorguidelines.pdf

American Psychological Association. (2013). *APA guidelines for the undergraduate psychology major: Version 2.0.* Retrieved from http://www.apa.org/ed/precollege/undergrad/index.aspx

Christopher, A. N., Walter, M. I., Horton, R. S., & Marek, P. (2007). Benefits and detriments of integrating statistics and research methods. In D. S. Dunn, R. A. Smith, & B. Beins (Eds.), *Best practices for teaching statistics and research methods in the behavioral sciences* (pp. 187–202). Mahwah, NJ: Erlbaum.

Dweck, C. S. (2006). *Mindset: The new psychology of success.* New York, NY: Random House.

Fink, L. D. (2013). *Creating significant learning experiences: An integrated approach to designing college courses* (Rev. ed.). San Francisco, CA: Jossey-Bass.

Freng, S. (2020). Predicting performance in upper division psychology classes: Are enrollment timing and performance in statistics and research methods important? *Teaching of Psychology, 47*(1), 24–33. https://doi.org/10.1177/0098628319888086

Freng, S., Webber, D., Blatter, J., Wing, A., & Scott, W. D. (2011). The role of statistics and research methods in the academic success of psychology majors: Do performance and enrollment timing matter? *Teaching of Psychology, 38*(2), 83–88. https://doi.org/10.1177/0098628311401591

Friedrich, J. (1996). Assessing students' perceptions of psychology as a science: Validation of a self-report measure. *Teaching of Psychology, 23*(1), 6–13. https://doi.org/10.1207/s15328023top2301_1

Garfield, J., & Ben-Zvi, D. (2007). How students learn statistics revisited: A current review of research on teaching and learning statistics. *International Statistical Review, 75*(3), 372–396. https://doi.org/10.111/j.1751-5823.2007.00029.x

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

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., Schuh, J. H., & Whitt, E. J. (2010). *Student success in college: Creating conditions that matter.* San Francisco, CA: Jossey-Bass.

Landrum, R. E., & Smith, R. A. (2007). Creating syllabi for statistics and research methods courses. In D. S. Dunn, R. A. Smith, & B. Beins (Eds.), *Best practices for teaching statistics and research methods in the behavioral sciences* (pp. 45–57). Mahwah, NJ: Erlbaum.

Lewthwaite, S., & Nind, M. (2016). Teaching research methods in the social sciences: Expert perspectives on pedagogy and practice. *British Journal of Educational Studies, 64*(4), 413–430. https://doi.org/10.1080.00071005.2016.1197882

Maki, P. L. (2002). Developing an assessment plan to learn about student learning. *Journal of Academic Librarianship, 28*(1), 8–13.

Maki, P. L. (2004). Maps and inventories: Anchoring effects to track student learning. *About Campus, 9*(4), 2–9. https://doi.org/10.1002/abc.99

Onwuegbuzie, A. J., & Wilson, V. A. (2003). Statistics anxiety: Nature, etiology, antecedents, effects, and treatments—A comprehensive review of the literature. *Teaching in Higher Education, 8*(2), 195–209. https://doi.org/10.1080/1356251032000052447

Papanastasiou, E. C., & Zembylas, M. (2008). Anxiety in undergraduate research methods courses: Its nature and implications. *International Journal of Research & Method in Education, 31*(2), 155–167. https://doi.org/10.1080/17437270802124616

Stanovich, K. E. (2019). *How to think straight about psychology* (11th ed.). New York, NY: Pearson.

Stoloff, M. L., Curtis, N. A., Rodgers, M., Brewster, J., & McCarthy, M. A. (2012). Characteristics of successful undergraduate psychology programs. *Teaching of Psychology, 39*(2), 91–99. https://doi.org/10.1177/0098628312437721

Stoloff, M., McCarthy, M., Keller, L., Varfolomeeva, V., Lynch, J., Makara, K., ... Smiley, W. (2010). The undergraduate psychology major: An examination of structure and sequence. *Teaching of Psychology, 37*(1), 4–15. https://doi.org/10.1080/00986280903426274

Suskie, L. (2018). *Assessing student learning: A common sense guide* (3rd ed.). San Francisco, CA: Jossey-Bass.

Wagner, C., Garner, M., & Kawulich, B. (2011). The state of the art of teaching research methods in the social sciences: Towards a pedagogical culture. *Studies in Higher Education, 36*(1), 75–88. https://doi.org/10.1080/03075070903452594

Wiggins, G., & McTighe, J. (1998). *Understanding by design.* Alexandria, VA: Association for Supervision and Curriculum Development.

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 193-224.
doi: 10.14434/josotl.v21i1.30273

Undergraduate Research Communities for Transfer Students: A Retention Model Based on Factors That Most Influence Student Success

Donna Chamely-Wiik
Florida Atlantic University
dchamely@fau.edu

Evelyn Frazier
Florida Atlantic University
efrazier@fau.edu

Daniel Meeroff
Florida Atlantic University
dmeeroff@fau.edu

Jordan Merritt
Florida Atlantic University
jmerrit8@fau.edu

Jodiene Johnson
University of Washington

William R. Kwochka
Western Carolina University
kwochka@ wcu.edu

Alison I. Morrison-Shetlar
University of Lynchburg
president@lynchburg.edu

Michael Aldarondo-Jeffries
University of Central Florida
maj@ucf.edu

Kimberly R. Schneider
University of Central Florida
krs@ucf.edu

Abstract: Transfer students face many challenges integrating into a 4-year college that affect their retention and success, yet very little research has documented how to create wraparound programming to support them. There remains a need to establish retention models that are adaptable and can serve a variety of students and institutions. The Learning Environment and Academic Research Network (LEARN) Consortium, a partnership of Florida Atlantic University, University of Central Florida, and Western Carolina University whose focus is on engagement in undergraduate research, addressed this need by developing and testing T-LEARN, a new model for a sustainable science, *technology, engineering, and mathematics (STEM) retention program specifically for transfer students who have transitioned to a university setting after receiving their associate's degree at a community college. The new model was developed by adapting a successful retention model for 1st-year students at the University of Central Florida centered around three main pillars: (1) academics/research, (2) mentoring, and (3) community building. In this paper, we describe the development of the T-LEARN model, outline the adaptations made to accommodate the specific needs of transfer students, and present 3 years of implementation data we analyzed to determine what factor(s) most impact transfer student retention and success. Our findings indicate that T-LEARN students' involvement in research during their 1st year was the most significant factor within the T-LEARN program that contributed to their academic success. Additionally, the majority of these students had continued to do research with the same LEARN program faculty mentor 1 year after the program ended.*

Keywords: undergraduate research, transfer students, model for transfer student retention, learning community.

Introduction

Recruitment and retention of students from the community college pathway to science, technology, engineering, and mathematics (STEM) careers is a national challenge. Community colleges serve a diverse student body including ethnically underrepresented minorities, women, first-generation students, veterans, older students, international students, and working parents. In particular, ethnic minorities who are underrepresented in STEM fields are disproportionately enrolled in community colleges (National Research Council [NRC], 2012). In 2004, almost half of all Americans that received their bachelor's degree in STEM fields attended community college at some point during their academic career (Tsapogas, 2004). As reported by the American Association of Community Colleges in March 2020 (AACC, 2020)[1], there were 1,050 community colleges in the United States serving approximately 11.8 million students (IPEDS 2018). Community college students represented 41% of all U.S. undergraduates and 29% of all first-generation students, with 52% of all Hispanic students and 42% of all Black students beginning their higher education careers at community colleges. Of this group, 62% of full-time community college students and 72% of part-time students worked either part- or full-time to earn money to attend school.

After transferring from a community college to a 4-year institution, transfer students (in particular, underrepresented minorities and women) face several obstacles to completing their undergraduate degrees, including difficulty transitioning to a new campus, a lack of social support, higher levels of nonacademic commitments, and financial concerns (Dougherty & Kienzl, 2006; Doyle, 2009; Eagan & Jaeger, 2009). In a study conducted at 72 institutions (Noel-Levitz, 2013), 44% of 4-year public institutions ranked their first-time-in-college (FTIC) retention programs as very effective, as compared to only 15% for their transfer student programs. Additionally, the National Survey of Student Engagement (NSSE) results indicate that, on average, transfer students from both community colleges and other 4-year institutions reported a lower level of engagement in high-impact educational activities, such as faculty-mentored research, compared to FTIC students. Likewise, the NSSE results show that transfer students generally had fewer interactions with faculty and consequently ranked their campus relationships lower compared to FTIC students who stayed at one institution for their 4-year academic career (see pages 11 and 15 in Kuh, 2009).

Compared to FTIC students, transfer students at a 4-year institution reported more difficulty in developing academic connections (Townsend & Wilson, 2006) and social interactions (Ishitani &

[1] Sources and dates of studies can be found in the Fast Facts (AACC, 2020, p.2)

McKitrick, 2010). Additionally, these students may have been living off campus, which negatively affects student/faculty interactions (Ishitani & McKitrick, 2010). The difficulty transfer students often face when transferring to a 4-year institution can result in a decrease in their first- or second-semester grade point average (GPA) at the university, a circumstance known as "transfer shock" (Hills, 1965). Transfer shock has also been determined to be even more pronounced for transfer students who major in the STEM disciplines (Carlan & Byxbe, 2000; Cedja, Kaylor, & Rewey, 1998; D'Amico, Dika, Elling, Algozzine, & Ginn, 2014).

Several pretransfer factors have been associated with students successfully transferring to a 4-year institution from a 2-year institution, including being younger in age, being academically prepared (i.e., not taking remedial coursework and instead taking higher level courses), and demonstrating continuous enrollment at the 2-year institution (D'Amico et al., 2014). The posttransfer factors that predict student success at their 4-year institution include higher transfer GPA (Carlan & Byxbe, 2000; Luo, Williams, & Vieweg, 2007; Mullen & Eimers, 2001; Pennington, 2006; Wang, 2009; Zhai & Newcomb, 2000), transferring with more credits (D'Amico et al., 2014; Ishitani, 2008; Luo et al., 2007), being a female student (Wang, 2009), majoring in non-STEM fields (Carlan & Byxbe, 2000; Mullen & Eimers, 2001), being a nonminority student (Mullen & Eimers, 2001), belonging to a higher socioeconomic class (Wang, 2009), and having greater involvement or integration in campus life (Luo et al., 2007; Wang, 2009).

Once transferred, the literature reports, transfer students can improve their acclimation by participating in bridge programs, research internships (Russell, Hancock, & McCullough, 2007), learning communities (Scott, Thigpin, & Bentz, 2017), and supportive mentorship programs (Gatta & Trigg, 2001). Academic integration and social integration of transfer students into 4-year institutions have shown to be the most important posttransfer factors in predicting persistence and degree completion (Bers & Smith, 1991; Karp, Hughes, & O'Gara, 2010; Laanan, 2007; Pascarella, Smart, & Ethington, 1986). Transfer students who participated in student organizations or social activities on campus reported greater persistence at the institution (Karp et al., 2010) and better social integration in their 4-year institution with no other factor, including ethnic group, socioeconomic status, or first generation in college, having a significant impact (Laanan, 2007).

In this paper, we describe the development and assessment of T-LEARN (Transfer-Learning Environment and Academic Research Network), a program developed with the primary objective of increasing retention and student success in STEM transfer students as they enter 4-year universities in the LEARN Consortium. T-LEARN is supported through a collaborative grant from the National Science Foundation (NSF) and has been implemented at the three institutions that make up the LEARN Consortium: Florida Atlantic University (FAU), University of Central Florida (UCF), and Western Carolina University (WCU). T-LEARN was adapted from F-LEARN, an FTIC program at UCF (Schneider & Bickel, 2015; Schneider, Tripp, Nair, Straney, & Lancey, 2015; Schneider et al., in press) and was modified to address the specific needs of transfer students as described earlier. In alignment with F-LEARN, this program focuses on three pillars to establish a transfer model: (1) encouraging participation in *undergraduate research* to promote academic integration, (2) providing multiple tiers of *mentoring* to address transfer shock, and (3) promoting *community building* as a means of social integration. Justification for inclusion of these three pillars is summarized as follows.

Undergraduate Research

Undergraduate research is a high-impact educational practice for enhancing student success (Boyer Commission on Educating Undergraduates in the Research University, 2003; Kuh, 2008). Early involvement in research is one of the most effective ways to interest students in STEM fields and keep them engaged (NRC, 2012). Student engagement in research can also facilitate social integration, a factor known to lead to higher persistence in transfer students (Townsend & Wilson, 2006). A large body of literature (Brewer & Smith, 2011; Dolan & Johnson, 2009; Kenny et al., 2001; NRC, 2012) has documented the effectiveness of actively engaging undergraduate students in research and inquiry to support undergraduate learning. In addition, these studies have indicated that engagement in research increases the probability that students will remain in college (Nagda et al., 1998), show increased academic achievement and graduation rates (Bauer & Bennett, 2003; Craney et al., 2011), and pursue graduate education and/or additional research opportunities (Hathaway, Nagda, & Gregerman, 2002; Lopatto, 2003; Russell et al., 2007). These improvements in retention and persistence were especially high with underrepresented students (Adhikari & Nolan, 2002; Barlow & Villarejo, 2004; Hunter, Laursen, & Seymour, 2007; Laursen, Hunter, Seymour, Thiry, & Melton, 2010). In addition, students who participated in undergraduate research show improvements in their fundamental critical thinking skills compared to their peers (Hunter et al., 2007; Kardash, 2000; Lopatto, 2007), had experiences that positively impacted their personal and professional development (Seymour, Hunter, Laursen, & Deantoni, 2004), and integrated more strongly into the academic setting as members of the scientific community (Bergquist & Pawlak, 2008; Hurtado et al., 2011). Unfortunately, transfer students do not usually have as many undergraduate research opportunities compared to students who started as 1st-year students in 4-year institutions. Most students who graduate with an associate's degree from a 2-year college transition to a 4-year university in the semester immediately following graduation, reducing the window of time to develop relationships with their professors and social networks to help access research experiences. Furthermore, the NRC (2012) reported that transfer students tend to work full- or part-time, rely more on public transportation, need help with childcare, and require financial support to participate fully in undergraduate research.

Mentoring

Mentoring has been identified as one of the key components of undergraduate student success in STEM disciplines, especially for underrepresented STEM students (Fifolt & Abbott, 2008; Gibson & Angel, 1995; LaBonty & Stull, 1993; Payton, 2004). Unlike traditional students that live on campus, many transfer students travel to campus only to attend classes or mandatory activities, so their time spent in class is even more critical to the development of both their academic and their social connections (D'Amico et al., 2014). Since transfer students spend less time on campus compared to the traditional college student, their in-class time is most likely their only time to identify a faculty or staff member to serve as a mentor. Having fewer mentored research opportunities available to them is a deficit that may be offset by having high-quality mentoring experiences with well-trained faculty members. Studies have shown that mentor training for faculty provides a better and more consistent undergraduate student research experience (Handelsman, Pfund, Lauffer, & Pribbenow, 2005; Bickel & Schneider, 2013). Mentoring is especially beneficial when several mentors are involved in the process (Higgins & Kram, 2001; Johnson, 2007).

Community Building

Community-building strategies have been extensively studied for incoming 1st-year students to promote student connections to the university community and increase their retention through academic and social engagements, but few studies have addressed how those same strategies affect transfer student retention (Gatta & Trigg, 2001; Scott et al., 2017). In this paper, we focused on the theory of academic involvement as it applies to transfer students and addressed students' academic and social integration as separate factors (Astin, 1984). Laanan (Laanan, Starobin, & Eggleston, 2010) indicated that the factors that positively correlated with transfer student academic integration to 4-year institutions were participating in academic workshops, student perceptions of faculty (being easy to approach), and numbers of hours per week studying. The positive factors associated with social integration were the number of weekly hours spent socializing with friends, psychological adjustment, and satisfaction with 4-year-institution experience (Laanan, 2007).

Although academic integration, such as participating in university programs and student organizations, as well as applying for scholarships, has been shown to have a high impact on a transfer student's overall undergraduate experience, proper social integration can also play a prominent role in the development of community. To promote the social integration of transfer students, we provided social activities that students attended outside of class that were scheduled around these students' lives (sometimes during class time) throughout the semester, so that students could get to know each other and form bonds with their peers and faculty (Jefferson, Dougherty, Steadman, & Thomas, 2013).

Purpose

Although previous research has provided evidence and information about transfer shock, including identifying factors that predict overall transfer student success, there is a lack of evidence on the factors that specifically impact the retention and success rates for transfer students majoring in STEM (Townsend & Wilson, 2006; Seymour et al., 2004). The same literature also shows the strong benefits of undergraduate research, establishing learning communities, and the need to retain transfer students. However, we have found no literature on the effectiveness of these independently implemented practices, or other STEM-specific transfer retention programs, that are integrated within an undergraduate research-focused initiative. The premise and practice of the T-LEARN program on the other hand, is to holistically integrate the practice of undergraduate research, social integration, and multi-tiered mentoring in a way that promotes the success of transfer students majoring in the STEM disciplines.

We sought to address this gap in the literature by developing a transferable retention model for STEM transfer students that simultaneously integrates a mentored *undergraduate research* experience, coupled with two classroom experiences aimed at developing students' research skills, with a multitiered *mentoring* structure and intentional *community-building* activities. The central question that has guided our research and analysis over the last 5 years has been this: Which of the identified factors (research, mentoring, and community building) most influence transfer student success and impact transfer student retention in a STEM research community?

Method

Definition of terms used. The definitions of key terms used throughout the study in the T-LEARN program are summarized in Table 1.

Table 1. Operational definition of terms used and personnel roles in the T-LEARN program.

Term	Definition	Roles
LEARN (Learning Environment and Academic Research Network)	A network of academic professionals and students who support and advocate for students participating in undergraduate research	
T-LEARN	LEARN for the transfer community	
Peer mentor	An upper division undergraduate or graduate student who serves as a student mentor to the T-LEARN students[a]	• Meet individually with students initially weekly (fall) and then biweekly (spring) to advise on assignments, adjusting to the university, and getting involved in research etc. • Coordinate and attend community-building events • For TAs: Review and grade students' drafts of written assignments
Research mentor	A faculty member, postdoctoral researcher, graduate student, or upper division undergraduate with advanced research experience within the university who serves as a research mentor to T-LEARN students	• Train students on specific research skills required to develop a research project • Review students' presentations • Mentor students
PI	Principal investigator or coinvestigator within the T-LEARN program faculty	• Implement grants • Teach the introduction to research courses • Mentor and advocate for students participating in undergraduate research via T-LEARN
LEARN program coordinator	A part- or full-time staff member who supports the LEARN program	• Coordinate all aspects of advertisement, recruitment, admissions, payment of stipends, work study documentation, communication with students, and administration of the LEARN program • Mentor students • Conduct program data analysis • Optional: Coteach LEARN classes

Term	Definition	Roles
T-LEARN alumni	Transfer students who successfully completed all requirements of the year-long T-LEARN program	• Continue advocating for undergraduate research • Complete follow-up surveys • Optional: May serve as peer mentors
A.A. degree[b]	Associate of arts degree	
A.S. degree[b]	Associate of science degree	
First-generation student	Student whose parents or guardians did not earn a 4-year degree (Higher Education Act 1965)	
Underrepresented minority (URM) student	Student who identifies as African American, Hispanic, American Indian, and/or Alaskan Native (NSF, 2019)	

[a] Some institutions use peer mentors as teaching assistants (TAs). Members of this group are also T-LEARN alumni.
[b] An A.A. or A.S. degree from a community college was required for acceptance into T-LEARN.

T-LEARN: A Three Institution Collaboration

The various components of the F-LEARN program within the three pillars (undergraduate research, mentoring, and community building), and how modifications were made to meet the specific needs of transfer students, are described in Table 2.

Table 2. Comparison of F-LEARN and T-LEARN programs.

Program information	F-LEARN	T-LEARN
	General	
Student admission status	Incoming FTIC student with credit hours which classify them as a 1st year student; institution-specific minimum entry level GPA; not in other learning communities	Incoming transfer student with a 3.0 GPA[a] and associate's degree (some pre-associate's); not in other learning communities
Program length	One academic year (fall and spring semesters)	Same as F-LEARN
Credit load	Full time at the start of the semester	Same as F-LEARN

Program information	**F-LEARN**	**T-LEARN**
Target population	First-generation and/or underrepresented minorities in STEM	Same as F-LEARN
Scholarship	$500	$2,000; higher stipend provided to reduce some of their need to work
Student major	B.S. degree track in a STEM field[b]	Same as F-LEARN
	Research	
Research experience	12-week apprenticeship, 3 hr/week minimum (36 hr); shadowing may occur prior if paired in fall	8–15 hr/week directed independent research experience for 16–20 weeks (128–300 hr); may start earlier if paired in fall T-LEARN research time requirement[c] was much higher than the F-LEARN model since transfer students were coming in with 2 years less time to engage in research and build faculty connections
Courses	Introduction to Research I (fall) and II (spring), one or more credits	Same as F-LEARN
Course outcomes	Matching with a research mentor, learning critical comprehension of research literature, and creating components of a research proposal	Conducting a research literature review, establishing a testable research question/hypothesis, and delivering a classroom research presentation (presentation at campus showcase is encouraged)
	Mentoring	
Research mentor	Faculty member, postdoctoral researcher, graduate student, or upper division undergraduate	Same as F-LEARN
Program PI/Staff	Faculty and staff: Course instruction, overall guidance/support	Same as F-LEARN

Program information	**F-LEARN**	**T-LEARN**
Peer mentors	Upper division undergraduate STEM students with advanced research experience and LEARN training. LEARN alumni when possible. Provide structured one-on-one check-in meetings with students	Same as F-LEARN
	Community building	
Orientation	1- to 2-day orientation within first weeks of fall classes. More than one session offered to accommodate student schedules	Same as F-LEARN
Residential requirement	Variable by campus	None
Academic, social, and community events	Required to attend events totaling six points each semester from a variety of events offered at different times, dates, and locations to work with varying student availability. Events include academic (seminars, workshops, etc.), social (e.g., family weekend, movie nights, pep rallies), and community service events	Same as F-LEARN
Academic, social, and community structure	Residential FTIC students centered around campus housing social activities. Some commuter events for nonresidential students, same as for T-LEARN	T-LEARN commuter events offered to account for the limited additional time that transfer students must participate in on-campus activities. Several activity options are offered on days when transfer students would already be on campus or on weekends to better accommodate their schedules

Note. A.A. = Associate of arts degree; A.S. = Associate of science degree; B.S. = bachelor of science degree; FTIC = first time in college; GPA = grade point average; LEARN = Learning Environment and Academic Research Network (F = 1st-year students, T = transfer students); NSF = National Science Foundation; PI = principal investigator; STEM = science, technology, engineering, and mathematics.

[a] GPA of 3.0 or above was used as a selection criterion because the institution minimum GPA to receive a scholarship is 3.0, and the NSF LEARN program includes a stipend that was distributed as

a scholarship for participation/completion.
[b] See the Appendix for a list of Classification of Instructional Programs codes that map to STEM majors for this project.
[c] Students select projects that fit the student's time availability and are approved by their research mentors.

Recruitment and Selection

Within the LEARN Consortium, we used several best practice strategies to inform students about the T-LEARN program: active recruitment of students that either had or were earning an A.A./A.S. degree from a feeder 2-year institution; collaboration with admissions staff and STEM faculty to distribute marketing materials and attain newly admitted student information for email recruiting; and providing in-class presentations targeting STEM students in key courses at the 2-year institution. Faculty, staff, and student organizations from state and community colleges were found by searching institution websites and collaborating with alumni who work at the state and community colleges. Transfer students with an A.A. or A.S. degree already admitted to one of the corresponding LEARN Consortium institutions were recruited through email, university program showcases, and orientation events. Posters and flyers about the T-LEARN program were developed at each consortium institution and distributed to contacts at state and community colleges and at recruitment events. University email to newly admitted STEM students appears to have been the most effective recruitment tool because of the ability to target students already committed to the institution and most likely to apply to an internal research program; however, giving presentations at state and community colleges each semester allowed students at those institutions to experience multiple touchpoints with the LEARN staff and the chance to develop a relationship and interest before applying. Each institution set up a dedicated LEARN website to disseminate information and advertise the online application that requested general information, short responses to questions, transcripts (unofficial or official), and letters of recommendation. Applications were accepted on a rolling basis and vetted by the program coordinator and PIs from the corresponding consortium institution. Some institutions included phone, video, or in-person interviews in their decision making. Final acceptance decisions were made after application review.

To participate in the T-LEARN program for the academic year, undergraduate transfer students needed to satisfy the following entry criteria:

- Enter directly from a 2-year institution with an earned A.A./A.S. degree prior to the summer or fall starting date with 60 or more credits
- Declare a major in a STEM field (see the Appendix for a list of Classification of Instructional Programs codes that map to STEM majors for this project) in pursuit of a bachelor of science degree
- Achieve a minimum transfer GPA of 3.0 or above from their transfer institution
- Not participate in another Living-Learning Community or other Enriching Learning Experience at the same time as T-LEARN (e.g., honors in the major, National Merit Scholars, mentoring programs, etc.).

After the application and review process, the PIs and program coordinators at each of the three institutions selected cohorts of 10–24 transfer students each year for 3 years. Priority was given to ethnically underrepresented minorities and first-generation students. The target experimental study sample included all the T-LEARN students from the years 2016–2018 (N = 133) from FAU (three cohorts), UCF (three cohorts), and WCU (two cohorts).

Matched Intrainstitutional Comparison Group

At the beginning of the fall term, the entire population of enrolled undergraduates in STEM disciplines at each institution was identified from official student tables to determine a paired comparison group as described in Meeroff et al. (2019). Briefly, the census data subset was based on the following factors: (1) entry status into the university; (2) first academic term of enrollment; (3) declared STEM major in their first term; (4) no participation in another Living-Learning Community or other resident Enriching Learning Experience; and (5) transfer GPA. To ensure that Factor 5 was consistently applied, we computed the minimum and maximum previous institution GPA for the T-LEARN cohort and removed any students from the population that had GPAs outside this range. Once this population of STEM undergraduates was identified, a stratified sample of approximately 100 students per institution was randomly selected as the comparison group for each T-LEARN cohort. Sample sizes of the T-LEARN cohorts and associated comparison groups per institution can be found in Table 3. Factors used to implement stratified sampling included (1) gender (two levels: male, female), (2) ethnicity (four levels: White, Black, Hispanic, other), and (3) previous institution GPA indicator (2 levels: below or above the median value). Although there were variations within each institution's ability to establish a large-enough comparison group ($n \approx 100$), all institutions were consistent in applying the variables described above to determine the stratified sampling.

Table 3. All 2016–2018 T-LEARN consortium cohorts from three institutions and paired comparison student demographics.

Variable	**FAU (3 cohorts)**		**UCF (3 cohorts)**		**WCU (2 cohorts)**	
	T-LEARN (*N* = 44)	**Comparison (*N* = 243)**	**T-LEARN (*N* = 64)**	**Comparison (*N* = 274)**	**T-LEARN (*N* = 25)**	**Comparison (*N* = 135)**
Transfer GPA	3.52	3.44	3.53	3.49	3.50	3.41
Gender						
Female	55%	49%	59%	58%	48%	19%
Male	45%	51%	41%	42%	52%	81%
Ethnicity						
URM	75%	49%	70%	65%	16%	8%
White	20%	35%	27%	21%	84%	79%
Other	5%	16%	3%	14%	0%	13%
Major						
Science	64%	70%	50%	47%	52%*	39%

Variable	**FAU (3 cohorts)**		**UCF (3 cohorts)**		**WCU (2 cohorts)**	
	T-LEARN (*N* = 44)	**Comparison (*N* = 243)**	**T-LEARN (*N* = 64)**	**Comparison (*N* = 274)**	**T-LEARN (*N* = 25)**	**Comparison (*N* = 135)**
Engineering	36%	30%	50%	53%	28%*	61%

Note. FAU = Florida Atlantic University; GPA = grade point average; T-LEARN = Transfer-Learning Environment and Academic Research Network; UCF = University of Central Florida; URM = underrepresented minority (Black, Hispanic, American Indian, Alaskan Native); WCU = Western Carolina University. *20% of the WCU cohort did not have a declared major (undeclared).

Data Collection

Data was collected from T-LEARN programs at the three institutions during the 2016–2018 academic years. FAU and UCF implemented T-LEARN in 2016 and each contributed data from three different cohorts (2016, 2017, and 2018). WCU implemented the T-LEARN program 1 year later in 2017 and contributed two cohorts (2017 and 2018) of data. The data sets used for this study are outlined below.

Student demographic data. Each university's Institutional Research Office provided de-identified demographic information on gender, ethnicity, declared major, first-generation status, and entry transfer GPA for both the T-LEARN students and the matched comparison group, as well as additional information about housing and Pell grant eligibility. For purposes of this analysis, each factor was analyzed for each individual institution using a two-tailed, paired *t* test. Unless otherwise noted, the T-LEARN cohorts from each university were not significantly different, which allowed us to combine the T-LEARN population to create one data set (*n* = 133), while also providing a snapshot of each institution's student demographics (see Tables 3, 4, and 5).

Table 4. Characteristics of the three partner institutions and undergraduate transfer student demographic data.

Variable	**Partner Institution**		
	FAU	**UCF**	**WCU**
Total number of students (undergraduate and graduate) (fall 2016)	37,452	69,525	10,382
Total number of undergraduate students (fall 2016)	24,225	55,253	9,171
Total number of FTIC students (fall 2016)	11,779	25,518	2,015
Total number of transfer students (fall 2016)	7,946	22,458	2,939

Variable	Partner Institution		
	FAU	**UCF**	**WCU**
Type of institution	Doctorate granting; Hispanic-serving institution (awarded 2017)	Doctorate granting; Hispanic-serving institution (awarded 2019)	Master's granting
Carnegie Classification	High research activity; community engaged	High research activity; community engaged	Community engaged
Percentage of transfer students from URM groups in STEM (in 2014)	55%	43%	19%

Note. A federally designated Hispanic-serving institution has an enrollment of undergraduate full-time equivalent students that is at least 25 percent Hispanic students at the end of the award year immediately preceding the date of application (DOE n.d.). FAU = Florida Atlantic University; T-LEARN = Transfer-Learning Environment and Academic Research Network; UCF = University of Central Florida; URM = underrepresented minority (Black, Hispanic, American Indian, Alaskan Native); WCU = Western Carolina University.

Table 5. Consortium and institution-specific demographics of T-LEARN participants, 2016–2018.

Variable	**Consortium aggregate (*N* = 133)**	**FAU (*N* = 44)**	**UCF (*N* = 64)**	**WCU (*N* = 25)**
Female	56%	55%	59%	48%
Male	44%	45%	41%	52%
URM	62%	75%	70%	16%
White	35%	20%	27%	84%
Other ethnicity	3.0%	4.6%	3.1%	0.0%
Pell grant eligible	59%	52%	66%	64%
Living on campus	13%	11%	4.7%	36%
First generation	53%	61%	42%	64%
Completed the program	83%	80%	80%	96%

Note. FAU = Florida Atlantic University; T-LEARN = Transfer-Learning Environment and Academic Research Network; UCF = University of Central Florida; WCU = Western Carolina University; URM = underrepresented minority (Black, Hispanic, American Indian, Alaskan Native).

Program completers versus noncompleters. Completers were defined as students who satisfied all requirements of the program, which included earning a passing grade (C or higher) in each of the two introduction to research courses, engaging in undergraduate research with a faculty mentor during the spring semester, regularly meeting with peer mentors, and satisfying the program engagement requirements. Noncompleters were defined as those who did not satisfy the requirements listed above and/or withdrew from the program for financial, personal, or other nonacademic reasons. Each institution recorded demographic information for their students in the program, and those data were aggregated to compare program completers and noncompleters (see Table 6).

Table 6. Consortium and institution-specific demographics of T-LEARN participants: completers versus noncompleters, 2016–2018.

Variable	Consortium aggregate (N = 133)		FAU (N = 44)		UCF (N = 64)		WCU (N = 25)	
	Completers (n = 110, 83%)	Noncompleters (n = 23, 17%)	Completers (n = 35, 80%)	Noncompleters (n = 9, 20%)	Completers (n = 51, 80%)	Noncompleters (n = 13, 20%)	Completers (n = 24, 96%)	Noncompleters (n = 1, 4.0%)
Female	55%	57%	51%	67%	63%	46%	46%	100%
Male	45%	43%	49%	33%	37%	54%	54%	0.0%
URM	57%	83%*	71%	89%	69%	77%	12.5%	100%
White	40%	13%	23%	11%	29%	15%	87.5%	0.0%
Other ethnicity	2.7%	4.4%	5.7%	0.0%	2.0%	7.7%	0.0%	0.0%
Pell grant eligible	58%	61%	43%	56%	67%	62%	62.5%	100%
Living on campus	11%	22%	5.7%	33%	3.9%	7.7%	33%	100%
First generation	53%	52%	66%	44%	39%	54%	62.5%	100%

Note. FAU = Florida Atlantic University; T-LEARN = Transfer-Learning Environment and Academic Research Network; UCF = University of Central Florida; URM = underrepresented minority (Black, Hispanic, American Indian, Alaskan Native); WCU = Western Carolina University.
*p = .023.

Follow-up survey. To provide student perceptions of various components of the program and postprogram activities, a follow-up survey was administered to T-LEARN students by an independent evaluator, 1 year after the students completed the program. For the fall 2016 and fall 2017 T-LEARN cohorts, students were invited by email to complete a survey three times, administered during spring 2018 and spring 2019 and made available for 6 weeks. The results were collated using the amount of time that had passed since the respondent participated in T-LEARN (e.g., fall 2016 = 2 years later and fall 2017 = 1 year later). A total of 13 questions were asked relating to student graduation status, future educational goals, continuation in research involvement after program completion, continuation in involvement in T-LEARN, ranking the value of each of the components, and perceptions of value gained by being part of T-LEARN. Data were summarized by each institution and provided to each of the PIs as a cumulative summary of all three institutions (see Table 7).

Table 7. Consortium average and institution-specific averages of characteristic rankings by T-LEARN students in the 2016 and 2017 cohorts, 1 and 2 years post-program.

Program characteristic	FAU			UCF			WCU	Consortium average	
	2016 (*N* = 19)		2017 (*N* = 15)	2016 (*N* = 20)		2017 (*N* = 22)	2017 (*N* = 13)		
	1 year after	2 years after	1 year after	1 year after	2 years after	1 year after	1 year after	1 year after	2 years after
Involvement in research	3.3	2.9	2.0	2.2	2.5	1.6	2.0	2.3 (*1*)	2.8 (*1*)
Faculty mentors	3.1	2.6	2.5	3.7	3.8	2.1	2.7	2.9 (*2*)	3.0 (*2*)
Peer mentors	3.2	3.5	3.5	2.8	3.5	3.4	4.7	3.3 (*3*)	3.5 (*5*)
Intro to research courses	3.2	3.1	2.7	3.5	3.3	4.3	3.3	3.5 (*4*)	3.2 (*4*)
Networking	2.9	3.5	4.8	4.0	2.3	4.3	2.7	3.7 (*5*)	3.1 (*3*)
Community	5.3	5.6	5.5	4.8	5.5	5.3	5.7	5.3 (*6*)	5.6 (*6*)
Response rate	68% (13/19)	58% (11/19)	40% (6/15)	55% (11/20)	30% (6/20)	50% (11/22)	31% (4/13)	51% (45/89)	44% (17/39)

Note. The six program characteristics were ranked on a scale of 1 (*most valuable*) to 6 (*least valuable*) by T-LEARN program alumni responding to surveys 1 year and 2 years postprogram; average rankings per institution are reported as well as averages for the consortium; overall rankings are given in parentheses and italics. FAU = Florida Atlantic University; UCF = University of Central Florida; WCU = Western Carolina University; T-LEARN = Transfer-Learning Environment and Academic Research Network, *Focus-group data*. To evaluate transfer student perceptions of the factors that most influenced their success and impacted their retention, annual student feedback was solicited through focus groups. A common Focus Group Guide containing both question sequences and follow-up question probes was used at each of the three institutions, and an independent focus group leader guided the sessions for each cohort at each institution. No program staff or PIs were present. Students were questioned and probed regarding the three pillars of the T-LEARN program, as well as transition and transfer shock challenges. Participation in the 1- to 2-hr focus group session was included as a course requirement, and students were assigned points for this activity at the end of the term. Points assigned were nominal and would not have significantly impacted the students' grade. Notes taken during the focus group, including student quotations, were submitted with no identifiable student indicators to the program PIs. The de-identified transcripts were provided to an independent evaluator to summarize key findings. Additionally, the independent evaluator also provided a cumulative focus group assessment for each cohort describing the program elements that produced the greatest student impact. Data from 3 years (2016–2018) of annual program focus group notes (from the focus group leaders) and the institutional annual summaries and final cumulative report summary 2016–2018 (from the independent evaluator) were used in this study (see Table 8). The T-LEARN study methodology was approved annually by all three universities' Institutional Review Board (FAU: 767795-1, UCF: 15-11382, WCU: 959817-1).

Table 8. Focus-group data compilation (anonymous) for T-LEARN students in cohorts 2016–2018.

Question	**Partner Institution**		
	FAU	**UCF**	**WCU**
1. Research experience			
What was the value of research experience?	• Love it • Waste of time • Very helpful • PI was hands-off, learned from graduate students • Networking • Lab students help with questions and provided support	• Overwhelmingly positive experience • Research experience should start earlier • Little contact with faculty mentor • Ten-hour weekly lab requirement is too much when taking courses • Most students report planning to continue	• Pretty good • Neutral (had to switch mentors 2 times)

Question	Partner Institution		
	FAU	UCF	WCU
What was the value of research courses?	• Learned a great deal of skills • How to read a scientific paper • Made a curriculum vitae • Research is hard, but I love it • Very challenging and hard	• Disconnect between expectations and outcomes • Identifying a faculty mentor is challenging • Too structured; needs more flexibility	• Great amount of information but course is too structured, would like to have learned about funding earlier to attend meetings • Needs flexibility to accommodate students who already know some of the content • Offer individualized pathway for students, maybe online
2. Mentoring			
Faculty/Coordinator teaching courses	• Great; were helpful with matching • Approachable, but would like more opportunities to meet outside of class	• Always helpful and available when needed	• Excellent support • Positive experience
Peer mentors	• Advice from mentors on similar majors • Helped find resources on campus • Made sure I was personally and emotionally OK • Could talk about everything	• Supportive • Supplemental guides always willing to converse and help • Immensely helpful; "walked the same path"	• Would have been better if our schedules had matched • Beneficial to have someone in my major 2 years ahead of me to speak to

Question	Partner Institution		
	FAU	UCF	WCU
LEARN coordinator	• Great help with anything and everything • Always available to listen about life • Supportive when you cry	• Helpful	• Supportive
3. Community or social integration			
Connecting with other T-LEARN students	• Studied with other T-LEARN students • Took classes together • Good to find students with common goals and serious about career • “Without T-LEARN, I would be lost” • “My only friends”	• T-LEARN created a “protective bubble” • Attending conferences brought students together • Friendships on a personal level decrease stress	• Spend time outside class • Academic support • “In engineering, I have no social life. Through T-LEARN I’ve met friends”
How would your experience have been different if you were not in the LEARN community?	• Would not have gotten involved in research • Would not have been challenged • Would not have submitted a grant • Would not get involved in organizations	• Would not have gotten involved in research; “very beneficial and helped the students achieve things that they believe they could not have done”	• Would not have gotten involved in research • Would not have had motivation to get through general education classes

Question	**Partner Institution**		
	FAU	**UCF**	**WCU**
What is your favorite aspect of the T-LEARN community?	• Getting involved in research • Overwhelming program but happy I did it because there was support • Gratifying due to challenging work, sense of accomplishment • I feel more accomplished when compared to other students • Networking • Conferences were great	• T-LEARN was a great experience but a lot of work • Getting into a laboratory • "Support system is really helpful" • "Pushing students to aim higher" • Sense that "we are in this together" • Study groups formed • "Great experience and though it is a lot of work, what you get in return is ten times what you put in"	• Getting involved in research
4. Transition to 4-year institution (transfer shock)			
How was your transition to a 4-year institution, and what challenges did you face?	• Same adjustment as to college • Longer commute • Study more • Balance work/life/classes	• Difficult • Loneliness • Hard classes • T-LEARN program has helped	• Easy from college • T-LEARN program facilitated transition

Question	Partner Institution		
	FAU	UCF	WCU
What strategies have you developed and would encourage other students to adopt?	• Time management • Weekly planner • Study on campus • Be open to learning • Take advantage of the resources being offered • Stick it out, it is worth it • Pay attention all the time • Do not take too many credits	• Not skipping classes • Making social media groups with other students in classes	• Develop a support group like T-LEARN • Get involved in clubs • Live close to campus • Seek help • Make friends with other T-LEARN students

Note. FAU = Florida Atlantic University; UCF = University of Central Florida; WCU = Western Carolina University; T-LEARN = Transfer-Learning Environment and Academic Research Network.

Results and Discussion

The T-LEARN program was implemented at three 4-year institutions that make up the LEARN Consortium with a goal of establishing a model that would be transferable to other institutions. The variability in student demographics at the three consortium institutions is important for understanding the transferability of the T-LEARN program and if the program best serves the independent institutions. The institutions vary in size from 10,382 students at WCU to 69,525 students at UCF. Both FAU and UCF are designated as Hispanic-serving institutions, and their T-LEARN programs consisted of 75% and 70% URM students, respectively (Table 3).

To determine the factors within each institution's STEM research community (research, mentoring, and community building) that most influence transfer student success and impact transfer student retention, a paired comparison group of similar students who were not involved in a structured research program was established. The paired comparison groups at each institution were matched as closely as possible to the corresponding T-LEARN cohorts by transfer GPA, gender, ethnicity, and majors. The T-LEARN cohorts from FAU aligned with the comparison group in all areas, except for percentage of URM participants. The T-LEARN cohorts at FAU were 75% URM students, while the comparison group was 49%. UCF aligned well with the comparison group in all areas and was made up of an even split of 50% students pursuing a science major and 50% students pursuing an engineering major. The cohorts from WCU were more diverse than the corresponding comparison groups from the same institution, with an average of 48% female and 16% URM students in the cohorts versus 19% and 7.4%, respectively, in the comparison group (Table 3).

With all T-LEARN program cohorts and corresponding comparison student groups starting with similar GPAs (no statistical difference found between entry GPAs, p = .197), we compared weighted average consortium and comparison group GPAs by semester, over the course of the program and 1 year following successful completion of the program. To determine if the T-LEARN students and/or the comparison group students experienced transfer shock, which is defined as a reduction in GPA over the first and second semester at a new institution, we compared reduction in weighted average GPA over the 1st year for all eight comparison groups from the three LEARN Consortium institutions. The results are presented in Figure 1. The T-LEARN students had a decrease in GPA from entry to fall and from fall to spring that was not statistically significant. The students in the comparison group who were selected in part based on matching previous-institution GPA (see the Method section) had a statistically significant decrease in GPA from entry to fall and from fall to spring during their 1st year. This statistically significant decrease in the comparison group cumulative GPAs over the 1st year of enrollment at the university level may be indicative of this population of STEM undergraduate students experiencing transfer shock (Cedja et al., 1998; D'Amico et al., 2014; Hills 1965). The smaller sample size ($N = 133$) of the T-LEARN group compared to the comparison group ($N = 652$) paired with more variability in the entry GPA of the T-LEARN students may have contributed to the reduction in GPA of the T-LEARN students not being statistically significant. However, it is worth noting that both the T-LEARN students and comparison group students showed a similar reduction trend in GPA, even if both populations did not show a statistically significant decrease.

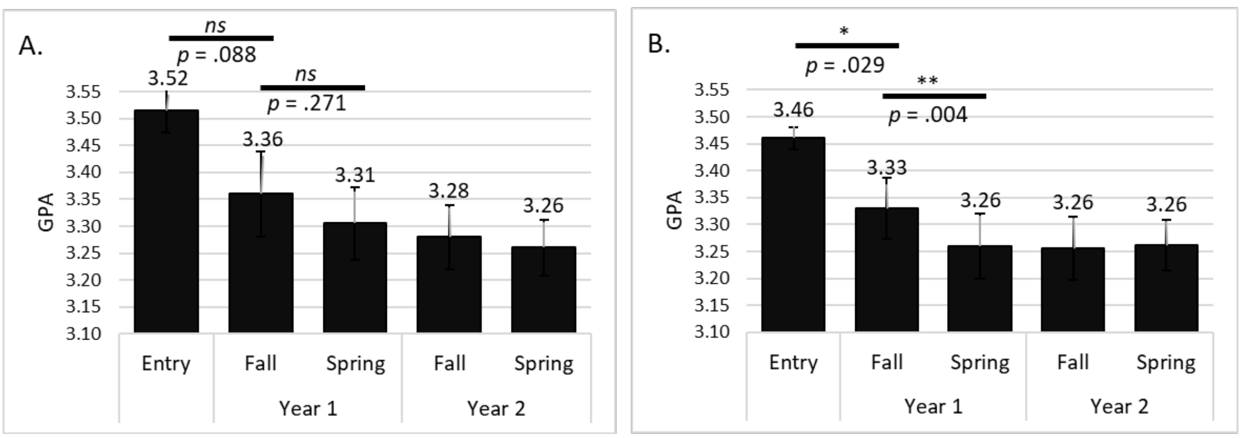

Figure 1. Combined cumulative GPAs for the 2016, 2017, and 2018 T-LEARN cohorts (A) and comparison groups (B) from FAU, UCF, and WCU. Data represent weighted average cumulative GPAs from entry through the fall and spring semester of their 1st year, compared to a matched comparison group. Significance was calculated using a two-tailed, paired *t* test. Error bars are standard errors of the means. The reported T-LEARN GPAs are a weighted average of eight cohorts of students from the three consortium institutions. The reported comparison GPAs are a weighted average of eight comparison groups from the three consortium institutions. FAU = Florida Atlantic University; GPA = grade point average; *ns* = not statistically significant; T-LEARN = Transfer-Learning Environment and Academic Research Network; UCF = University of Central Florida; WCU = Western Carolina University.

Assessing the Efficacy of the Model

We examined the demographic data by combining the T-LEARN student information from FAU (2016, 2017, 2018), UCF (2016, 2017, 2018), and WCU (2017, 2018). The combined T-LEARN cohorts from all three universities consisted of 133 students and demonstrated an 83% overall completion rate of the LEARN program. The totality of T-LEARN students from all three institutions was 56% female and 44% male. Of the T-LEARN students, 62% were URM, 35% were White, and 3.0% were other ethnicities. On average, 59% of the students were Pell grant eligible, 13% lived on campus, and 53% were first-generation college students. There was some variability in the demographics of T-LEARN cohorts from different institutions (Table 5).

For each of the demographic categories (gender, Pell grant eligibility, living arrangement, and first-generation status), a comparison of the overall student enrollment in the T-LEARN program (Table 5) with students who completed the program (Table 6) showed similar demographic profiles. From 2016 to 2018 at three institutions, the T-LEARN programs collectively had 110 students (83%) successfully complete the program and 23 (17%) noncompleters who left the program before finishing the second semester. However, there was some variation in the profiles of students successfully completing the program between the three individual institutions. WCU had two T-LEARN cohorts and the highest completion rate at 96%, compared to 80% for FAU and 80% for UCF. Interestingly, all three institutions had a higher percentage of URM students and students living on campus in their noncompleter group compared to successful program completers. This may mean that living off campus did not negatively impact the students' ability to successfully complete the program. A statistically significant difference was observed only for the higher percentage of URM students who did not complete the T-LEARN program (83%) compared to the percentage of URM students who did (57%, p = .023; Table 6). However, when we looked at the overall demographic profile of all program participants (Table 5), there was no statistically significant difference in the percentage of URM students who did not complete the program (p = .052).

The data in Table 6 suggest that there may be a difference in the success rates of the T-LEARN students based on ethnicity. We believe, however, that the statistical difference in the percentage of URM students successfully completing the program compared to not completing the program is a byproduct of not having a uniform URM representation across all three LEARN Consortium institutions. As reported in Table 5, the percentage of URM students in each T-LEARN program from 2016 to 2018 was 75% (FAU), 70% (UCF), and 16% (WCU). The high overall success rate of students completing the T-LEARN program, combined with a high percentage of non-URM students at WCU, resulted in an unequal distribution of non-URM and URM students who completed the program. With WCU data removed, 72% of the students in the overall program were from a URM group. Of the students who completed the program, 70% were from a URM group. Of the students who did not complete the program, 83% were from a URM group. The percentage of URM students who did not complete the program was not significantly different from either the percentage of URM students in the program overall (p = .35) or URM students successfully completing the program at UCF and FAU (p = 0.26).

Additional analysis, focus-group data, and follow-up surveys that were completed 1 and 2 years after students left the T-LEARN program resulted in the emergence of six major factors that students considered essential to their success that were common across all three institutions. Both FAU and UCF administered a survey 1 year and 2 years later to their 2016 T-LEARN cohorts and all three institutions administered a survey 1 year later to their 2017 T-LEARN cohorts. One of the questions in the survey asked the students from all three institutions to rank six components of the T-LEARN model in terms of the impact that the components had on their academic success (Table 7). These student-prioritized components and the results of the focus groups that were conducted every year for each cohort (Table 8) are used to discuss the various positive factors in the following sections.

Factors That Positively Affected Student Retention in STEM

Early access to undergraduate research experiences. Data from the follow-up survey (Table 7) suggest that students from all three institutions consistently identified early access to faculty-mentored research experiences *as the single most valuable factor* positively impacting their choice to continue to pursue their studies at the institution when surveyed 1 year after completing the program, and it remained the highest ranked activity even after 2 years. Focus-group data present similar findings and suggest that although these types of research experiences varied among students and institutions (e.g., some students learned laboratory techniques, supervised by graduate students and/or faculty mentors, while others conducted literature reviews), students still strongly identified engagement in undergraduate research as having the most powerful impact on their university experience (Table 8). Students from each cohort also recommended starting the laboratory research experience as early as possible in fall, to receive the greatest benefits from this most valuable experience. Within the focus groups, students also articulated that without the T-LEARN program "we would not have been challenged; never would have gotten into research." During the focus groups, when students were asked how their university experience would have been different if they had not been in the T-LEARN program, the responses included: "without involvement in research, I would not have been as engaged, I would have come to class, [gone] home and [done] homework" and "I would have not known about research" and "I would not have the courage or persistence to get a research mentor." Another student noted the following: "Less stress, but I choose stress; would be underprepared without LEARN."

We also probed T-LEARN alumni to see how many of the students continued in research; the 1-year-postprogram survey indicated that 85% (33 of 39) of T-LEARN alumni who completed the survey continued on in research, and 67% of them (26 of 39) continued for two or more semesters after T-LEARN. Because of their late entry into the university, transfer students are less likely to become involved in high-impact practices, which are known to build a sense of academic belonging at an institution (Zilvinskis & Dumford, 2018). Early engagement in research and interaction with STEM faculty teaching research courses provides transfer students with both academic integration and a sense of belonging to a scientific community; both have been shown to increase transfer student persistence and retention in 4-year institutions (Pascarella et al., 1986; Bergquist & Pawlack, 2008; Bers & Smith, 1991; D'Amico et al., 2014; Hurtado et al., 2011; Karp et al., 2010; Laursen et al., 2010; Townsend & Wilson, 2006).

Tiered mentoring—Research faculty mentors and faculty/staff teaching research courses. From the surveys administered 1 and 2 years postprogram, we learned that the second most valuable component of the program was interactions with faculty mentors (Table 7). Faculty mentoring consisted of (a) supervising research experiences in their laboratories and (b) teaching the introduction to research courses and serving as program PIs within the T-LEARN program (Table 1). Additionally, some PIs of the LEARN grant served as faculty research mentors to T-LEARN students. In the fall 2017 follow-up survey, 82% (27 of 33) of T-LEARN alumni who had continued in research reported that they retained the same research mentor 1 year later, and 66% (21 of 32) of these students retained the same mentor 2 years after completing the T-LEARN program.

Additionally, in all years of the program, students in each of the cohorts were overwhelmingly positive about their interactions with T-LEARN faculty and staff members who managed the T-LEARN program and taught the introduction to research courses. Students considered their mentorship invaluable and saw their mentor as accessible, reliable, and a valid source of information about the T-LEARN program and the institution (Table 8). Effective mentoring has been related to student retention in STEM, particularly URM students, and pursuit of STEM postgraduate careers (Byars-Winston, Branchaw, Pfund, Leverett, & Newton, 2015; Gloria & Robinson Kurpius, 2001; Gregerman, Lerner, Von Hippel, Jonides, & Nagda, 1998; Hathaway et al., 2002; Pfund, Byars-Winston, Branchaw, Hurtado, & Eagan, 2016).

Peer mentoring. The T-LEARN program's multiple levels of mentorship include faculty research mentors, T-LEARN program faculty and staff, and peer mentors. In addition to appreciating faculty mentors, the T-LEARN students surveyed also perceived peer mentoring to be a true strength of the program, especially when the mentoring was conducted by LEARN alumni. The peer mentors were ranked third on the survey administered 1 year postprogram and, interestingly, fifth on the survey 2 years postprogram. The decreased ranking from 1 year to 2 years postprogram coincided with an increased perception of the importance of networking. The peer mentors served as sources of valuable information to the students, both as confidants and as champions of student success. These positive interactions with the peer mentors contributed to the students' sense of belonging to the university and integration within the STEM scientific community, which is consistent with earlier findings (Townley et al., 2013; Tables 7 and 8). The peer-mentor relationships were described in the following ways: "felt comfortable to express frustrations and get help" and "felt like I had another friend" (Table 8).

The PIs met periodically with the peer mentors to discuss any issues related to engaging with students. The PIs also periodically queried the faculty mentors to determine how engaged the LEARN students were with their mentored research activities. This information was used for just-in-time advising at the individual level and for continuous improvement at the program level.

Introduction to research courses. Since early engagement in undergraduate research does not occur in a vacuum, our focus-group as well as survey findings highlighted multiple positive synergistic factors related to the T-LEARN program structure. Along with early access to undergraduate research, the T-LEARN program also provided a uniform and structured approach to preparing students for research, primarily through the two-semester introduction to research courses. One and 2 years following completion of the program, students rated this factor as the fourth most important aspect of the T-LEARN program. Additionally, when T-LEARN students were asked 1 and 2 years later whether the T-LEARN program prepared them to get involved in research, 100% of respondents characterized the T-LEARN program as a positive influence. Finally, when asked 1 year later if they thought that they would have become involved in research without T-LEARN, only 18% (6 of 33) of T-LEARN students responded they would have, and that percentage decreased to 13% (4 of 32) 2 years out from the program. Focus-group data also suggest that students would not be involved in research without the LEARN program, indicating that the traditional curriculum was too rigid and inflexible (Table 8).

Networking opportunities through a community of learners. One year after finishing the T-LEARN program, alumni ranked networking as the fifth most important valuable experience with the LEARN program. The same cohort ranked networking third on the survey given 2 years postprogram (Table 7). This shift in the perception of the importance of networking might have been caused by students realizing its value only after becoming more immersed in research and being exposed to more networking opportunities (such as presenting at regional and national conferences) as a result of gaining additional research experience. The community of learners we established with T-LEARN also seemed to extend beyond the program. When former T-LEARN students were asked whether they remained involved in the T-LEARN program after program completion, 52% (23 of 44) reported continued involvement 1 year after the program ended and 38% (15 of 40) remained involved 2 years later. Table 9 outlines the various ways students stayed involved in the T-LEARN program. Even though academic integration seems to be more important to transfer student retention and engagement, social integration is another factor that enhances student retention (D'Amico et al., 2014; Laanan, 2007).

Table 9. One and 2-year postprogram survey results for students who indicated continuing involvement in the T-LEARN program, 2016–2018.

Opportunity for Involvement[a]	1 year after (N = 22)	2 years after (N = 4)
Served as a peer mentor	36%	50%
Mentored T-LEARN researchers	23%	25%
Served on a T-LEARN panel or presentation	59%	75%
Attended events/workshops	45%	25%
Other	18%	0.0%

Note. T-LEARN = Transfer-Learning Environment and Academic Research Network.
[a]Respondents could choose more than one.

Community programming. Community engagement activities within the T-LEARN program were also valued by program participants at each institution. These provided academic, research, social, and emotional support to the students. In the summary report provided by the independent evaluator:

> Engagement with this community, as described by the students, impacted them in the following ways: 1. reduced stress; 2. bolstered grit and perseverance in STEM disciplines; 3. solidified identities as STEM majors and budding professionals; and 4. increased motivation to accomplish set goals.

Student comments such as "academically we are always talking about classes, assignments, graduate school," "socially we are out every other weekend with other LEARN students," "having a community ... if I was alone without T-LEARN, then I would be lost," and "friendships on a personal level decrease stress" suggest their interactions with other T-LEARN students extended outside of the T-LEARN program, and they were able to develop positive personal relationships that provided additional support. One student reported, "In engineering, I have no social life. Through LEARN I've met friends. Shared classes with them.... We help each other to succeed. I don't know how I would have made it." Another student stated that the T-LEARN program provided "my only friends, I only came with a roommate from … (a previous institution), a little comforting going through the whole research process with you" (Table 8).

Additional outcome: Goals after graduation. When T-LEARN alumni were asked what their future educational or professional goals were, in the follow-up survey given 1 year postprogram, 85% (35 of 41) indicated they intended to attend graduate school or pursue a professional degree. When asked 2 years postprogram, 75% (6 of 8) of respondents indicated interest in pursuing graduate or professional school. These findings are consistent with other studies where involvement in undergraduate research clarified students' interest in pursuing careers in STEM and increased consideration of pursuing a Ph.D. (Hathaway et al., 2002; Russell et al., 2007; Zydney, Bennet, Shahid, & Bauer, 2002).

Factors That Negatively Impacted Students

In addition to factors that positively impacted the students within the program, we also identified the following factors that negatively impacted student success at the university.

Readiness to transition to a 4-year institution or university. It is worth noting again that the T-LEARN students and the comparison groups showed a similar trend in GPA reduction over their first two semesters, even if this decrease was statistically significant only for the comparison group. The T-LEARN program may have allowed transfer students to navigate the transition better by providing opportunities to participate in higher academic and social integration STEM activities, such as research (Townley et al., 2013). Additionally, development and resource workshops were scheduled during the program to help with transitioning (e.g., Surviving College, Library Resource Tour, Center for Teaching and Learning Resource Tour, Laboratory Tours, Stress Management, Time Management, among others). Nevertheless, focus-group summaries indicated that T-LEARN students still felt underprepared for the rigors of a university. Common challenges reported were mostly of an academic nature and included but were not limited to course content being perceived as more rigorous compared to their previous institutions, insufficient one-on-one feedback and instruction, and a lack of availability of professors, and/or tutors to meet with students. The students' comments reflect their difficulty adjusting to their new academic home: "Coming here from community college to focus on my major, the pace was different," "I had to get accustomed to taking classes every day, multiple per day, including labs," "large difference in class size (20 before but about 40 here)…makes it challenging sometimes," "finding time to study for exams because there was so much homework," and "teaching style is different from the state college; sometimes I supplemented with YouTube." As a result of this feedback, some institutions in the consortium created a course for learning how to survive the university transition, and in engineering, one of the universities coordinated with the partner institutions to align course outcomes, textbooks, and syllabi to match the 4-year institution expectations.

The reduction in T-LEARN and comparison students' GPAs shows that college readiness issues existed in both our T-LEARN cohorts and the paired comparison groups, such as a lack of academic preparedness, a lack of understanding of the academic rigor, academic policies and procedures, and faculty expectations at a 4-year institution (Grites, 2013). Further investigation of academic preparedness is needed beyond GPA and credits attempted.

Time constraints. Students who did not continue on in research articulated that a lack of time was the major factor impeding their ability to participate and perform optimally academically. Focus-group data also indicated that difficulties with work/life balance, time management, increasingly challenging coursework, and longer commute times adversely impacted their ability to be effective. To investigate time constraints, we assessed the number of T-LEARN students who lived on and off campus and who also successfully completed all requirements of the program. Note, on-campus living was not a requirement for participation in the T-LEARN program. No significant difference was found, and living off campus did not seem to be a negative factor for completion (Table 6).

Having to work and go to school did, however, have an impact on students' academic success. In their own words: "Horrible, I missed class due to third shift, not sleeping," "Got to class but impaired, had to quit because it interfered," "Worked all day on the weekends, but the assignments were due." T-LEARN students are arriving at 4-year institutions with more academic and life experiences, but several reported that family commitments interfered with their academic life, as exemplified best by these comments: "Family, a 5-year-old," "Keeping house is a lot of work," and "Mom travels, so I take care of my siblings." These findings are consistent with those of Ishitani and McKitrick (2010), who also found that time constraints, due to a long commute, had a negative effect on student interaction with faculty during office hours or after class. Further investigation is needed to determine whether commute time, time spent meeting financial and family/personal obligations, or other support-system-related factors play an important role.

Financial need. Most of the transfer students stated that they needed employment to finance their academic life and could not dedicate the needed time to academics and research. We investigated the Pell grant eligibility status of the T-LEARN students as a measure of financial need. There were 79 students (59.0%) in the program who were Pell eligible, but we found no difference in program success compared to those who were not (Table 6). It is important to note that not all students file a Free Application for Federal Student Aid, which is necessary to be considered for a Pell grant, and those who do not are categorized as not Pell eligible even though they may have unmet financial need. Other studies have identified that low socioeconomic status can result in transfer students' needing to work to pay for their education, leading to a negative impact on transfer student retention at 4-year institutions (D'Amico et al., 2014; Wang, 2009). Further investigations are needed to determine more accurate measures of financial need and its impact on student success.

Implications and Conclusions

Our findings suggest that the T-LEARN program's academic and social interventions have positively impacted our students in a variety of ways. Early engagement in undergraduate research had the highest impact and mentorship by faculty had the second highest, and together they enhanced student success and sense of academic belonging. Additionally, tiered mentoring, networking, and a community of learners contributed to developing a sense of belonging to the scientific community on the campuses. T-LEARN students established lasting friendships within their cohorts and valuable relationships with peer mentors and faculty that they perceived helped them with the transition from their community colleges to a 4-year institution.

We considered several accommodations when establishing the T-LEARN program to ensure the success of these transfer students. Probably the most important one concerned participants' time constraints due to having more nonacademic responsibilities than traditional students who begin their academic career at a 4-year institution. We addressed this by having flexible, family-friendly scheduling of community and social activities. The financial burden of college was offset through generous stipends, and the on-campus living requirement was relaxed to accommodate the lifestyles of older students. Institutions interested in serving this unique population of transfer students should consider these factors when adopting this model program. Scheduling events during normal class time, on the same day as on-campus courses, and family-friendly events on the weekends helped the T-LEARN students fit many of the community programming events into their busy schedules. Our findings suggest that T-LEARN students may have been better able to cope with transitioning to a 4-year institution and avoiding transfer shock than comparison students who did not participate, despite the time commitment that this program may have added to their schedules. More investigation in this area is needed. Providing scholarships to the students to offset their need to work may have also positively impacted their ability to manage inclusion of the various program activities, especially engagement in research. To account for this, institutions may use creative solutions to fund students in research such as using federal or institutional work-study funds as a source of financial support for eligible candidates. Since a large percentage of students enroll in community colleges, and this population of students contains a high percentage of historically underrepresented groups, it is necessary to establish and support undergraduate research programs that are targeted to transfer students, such as the model described in this paper, at institutions that wish to identify and address the barriers facing transfer students and positively impact their success, retention, and ultimate graduation in STEM disciplines.

Acknowledgements

Funding for this project was provided by the NSF's IUSE program, grants 1524601, 1524666, and 1524607. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF. The authors would like to acknowledge Patrice Lancey, Uday Nair, and Rachel Straney from UCF's Operational Excellence and Assessment Support office, Ben Silva from FAU's Institutional Effectiveness and Analysis office, Colleen Smith and Mary Tripp from UCF's Office of Undergraduate Research, and Kloo Hanson from WCU's Office of the Provost for their assistance.

Appendix

Appendix 1: STEM CIP Codes.

Any academic program with a Classification of Instructional Programs (CIP) code beginning in 02, 03, 11, 14, 15, 26, 27, or 40 is defined as a STEM field (NCES n.d.).

References

Adhikari, A., & Nolan, D. (2002). But what good came of it at last? How to assess the value of undergraduate research. *Notices of the American Mathematical Society, 49*, 1252–1257.

American Association of Community Colleges. (2020). *Community college fast facts*. Retrieved from https://www.aacc.nche.edu/research-trends/fast-facts/

Astin, A. W. (1984). Student involvement: A developmental theory for higher education. *Journal of College Students Personnel*, *25*, 297–308.

Barlow, A. E., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching, 41*, 861–881. https://doi.org/10.1002/tea.20029

Bauer, K. W., & Bennett, J. S. (2003). Alumni perception used to assess undergraduate research experience. *Journal of Higher Education, 74*(2), 210–230. https://doi.org/10.1080/00221546.2003.11777197

Bergquist, W. H., & Pawlak, K. (2008). *Engaging the six cultures of the academy: Revised and expanded edition of the four cultures of the academy*. San Francisco, CA: Wiley.

Bers, T. H., & Smith, K. E. (1991). Persistence of community college students: The influence of student intent and academic and social integration. *Research in Higher Education*, 32, 539–556. https://doi.org/10.1007/BF00992627

Bickel, A., & Schneider, K. (2013). Early involvement in research: Developing graduate students as research mentors in a STEM living-learning community. In N. Dominguez & Y. Gandert (Eds.), *6th Annual Mentoring Conference Proceedings: Impact and Effectiveness of Developmental Relationships.* Albuquerque, NM: University of New Mexico.

Boyer Commission on Educating Undergraduates in the Research University. (2003). *Reinventing undergraduate education: Three years after the Boyer Report.* Stony Brook, NY: State University of New York at Stony Brook.

Brewer, C. A., & Smith, D. (2011). *Vision and change in undergraduate biology education: A call for action.* Washington, DC: Directorate for Biological Sciences, American Association for the Advancement of Science.

Byars-Winston, A., Branchaw, J., Pfund, C., Leverett, P., & Newton, J. (2015). Culturally diverse undergraduate researchers' academic outcomes and perceptions of their research mentoring relationships. *International Journal of Science Education*, *37*(15), 2533–2554.

Carlan, P. E., and Byxbe, F. R. (2000). Community colleges under the microscope: An analysis of performance predictors for native and transfer students. *Community College Review*, 28(2), 27–42.

Cedja, B. D., Kaylor, A. J., & Rewey, K. L. (1998). Transfer shock in an academic discipline: The relationship between students' majors and their academic performance. *Community College Review*, *26*(3), 1–13. https://doi.org/10.1177/009155219802600301

Craney, C., McKay, T., Mazzeo, A., Morris, J., Prigodich, C., & De Groot, R. (2011). Cross-discipline perceptions of the undergraduate research experience. *The Journal of Higher Education*, *82*(1), 92–113.

D'Amico, M. M., Dika, S., Elling, T. W., Algozzine, B., & Ginn, D. J. (2014). Early integration and other outcomes for community college transfer students. *Research in Higher Education,* 55, 370–399. https://doi.org/10.1007/s11162-013-9316-5

Department of Education (n.d.). *White House Hispanic Prosperity Initiative.* https://sites.ed.gov/hispanic-initiative/hispanic-serving-institutions-hsis/

Dolan, E., & Johnson, D. (2009). Toward a holistic view of undergraduate research experiences: An exploratory study of impact on graduate/postdoctoral mentors. *Journal of Science Education Technology*, *18*, Article 487. https://doi.org/10.1007/s10956-009-9165-3

Dougherty, K. J., & Kienzl, G. S. (2006). It's not enough to get through the open door: Inequalities by social background in transfer from community colleges to four-year colleges. *Teachers College Record, 108*(3), 52–487.

Doyle, W. R. (2009). Impact of increased academic intensity on transfer rates: An application of matching estimators to student-unit record data. *Research in Higher Education, 50*(1), 52–72.

Eagan, M. K., & Jaeger, A. J. (2009). Effects of exposure to part-time faculty on community college transfer. *Research in Higher Education, 50*(2), 168–188.

Fifolt, M., & Abbott, G. (2008). Differential experiences of women and minority engineering students in a cooperative education program. *Journal of Women and Minorities and Science and Engineering, 14*(3), 253–267.

Gatta, M., & Trigg, M. (2001). *Bridging the gap: Gender equity in science, engineering, and technology* (Report). Retrieved from https://pdfs.semanticscholar.org/706e/240c487a433759b6c825ed2761965813ff64.pdf

Gibson, L. K., & Angel, D. L. (1995). Mentoring: A successful tool for developing co-op students. *Journal of Cooperative Education, 30*(3), 48–55.

Gloria, A. M., & Robinson Kurpius, S. E. (2001). Influences of self-beliefs, social support, and comfort in the university environment on the academic non persistence decisions of American Indian undergraduates. *Cultural Diversity and Ethnical Minority Psychology*, *7*(1), 88–102.

Gregerman, S. R., Lerner, J. S., Von Hippel, W., Jonides, J., & Nagda, B. A. (1998). Undergraduate student-faculty research partnerships affect student retention. *Review of Higher Education 22*(1), 55–72.

Grites, T. J. (2013). Successful transitions from two-year to four-year institutions. *New Directions for Higher Education*, *2013*(162), 61–68. https://doi.org/10.1002/he.20057

Handelsman, J., Pfund, C., Lauffer, S. M., & Pribbenow, C. M. (2005). *Entering mentoring: A seminar to train a new generation of scientists*. Madison, WI: University of Wisconsin Press.

Hathaway, R. S., Nagda, B. R. A., & Gregerman, S. R. (2002). The relationship of undergraduate research participation to graduate and professional education pursuit: An empirical study. *Journal of College Student Development, 43*(5), 614–631.

Higgins, M. C., & Kram, K. E. (2001). Conceptualizing mentoring at work: A developmental network perspective. *Academy of Management Review, 26*(2), 264–288.

Higher Education Act of 1965, 20 U.S.C. § 1078a-1 (1965). https://www2.ed.gov/about/offices/list/ope/trio/triohea.pdf

Hills, J. R. (1965). Transfer shock: The academic performance of the junior college transfer. *The Journal of Experimental Education 33*(3), 201–215. https://doi.org/10.1080/00220973.1965.11010875

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*(1), 36–74. https://doi.org/10.1002/sce.20173

Hurtado, S., Eagan, M. K., Tran, M. C., Newman, C. B., Chang, M. J., & Velasco, P. (2011). We do science here: Underrepresented students' interactions with faculty in different college contexts. *Journal of Social Issues, 67*(3), 553–579. https://doi.org/10.1111/j.1540-4560.2011.01714.x

Integrated Postsecondary Education Data System. (2018). *The Integrated Postsecondary Education Data System* (Survey database). Retrieved from https://nces.ed.gov/ipeds/this-week-in-ipeds/view-list?year=2018

Ishitani, T. T. (2008). How Do Transfers Survive after "Transfer Shock"? A Longitudinal Study of Transfer Student Departure at a Four-Year Institution. *Research in Higher Education*, 49(5), 403–419. https://doi.org/10.1007/s11162-008-9091-x

Ishitani, T. T., & McKitrick, S. A. (2010). After transfer: The engagement of community college students at a four-year collegiate institution. *Community College Journal of Research and Practice*, *34*(7), 576–594, https://doi.org/10.1080/10668920701831522

Jefferson, G. D., Dougherty, F. C., Steadman, S., & Thomas, T. G. (2013). Transfer student retention. In *Proceedings of the 2013 ASEE Southeast Section Conference*. Retrieved from http://se.asee.org/proceedings/ASEE2013/ASEE2013SE%20frame.htm

Johnson, W. B. (2007). *On being a mentor: A guide for higher education faculty*. Mahwah, NJ: Erlbaum.

Kardash, C. M. (2000). Evaluation of undergraduate research experience: Perceptions of undergraduate interns and their faculty mentors. *Journal of Educational Psychology, 92*(1), 191–201. https://doi.org/10.1037/0022-0663.92.1.191

Karp, M. M., Hughes, K. L., & O'Gara, L. (2010). An exploration of Tinto's integration framework for community college students. *Journal of College Student Retention: Research, Theory and Practice, 12*(1), 69–86. https://doi.org/10.2190/CS.12.1.e

Kenny, S. S., Thomas, E., Katkin, W., Lemming, M., Smith, P., Glaser, M., & Gross, W. (2001). *Reinventing undergraduate education: Three years after the Boyer Report*. Stony Brook, NY: State University of New York at Stony Brook.

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. (2009). The national survey of student engagement: Conceptual and empirical foundations. *New Directions for Institutional Research*, *2009*(141), 5–20. https://doi.org/10.1002/ir.283

Laanan, F. S. (2007). Studying transfer students: Part II: Dimensions of transfer students' adjustment. *Community College Journal of Research and Practice*, *31*(1), 37–59. https://doi.org/10.1080/10668920600859947

Laanan, F. S., Starobin, S. S., & Eggleston, L. E. (2010). Adjustment of community college students at a four-year university: Role and relevance of transfer student capital for student retention. *Journal of College Student Retention: Research, Theory and Practic*e, *12*(2), 175–209. https://doi.org/10.2190/CS.12.2.d

Labonty, D., & Stull, W. A. (1993). Mentoring: A useful concept for cooperative education programs. *Journal of Cooperative Education, 28*(3), 12–20.

Laursen, S., Hunter, A. B., Seymour, E., Thiry, H., & Melton, G. (2010). *Undergraduate research in the sciences: Engaging students in real science*. San Francisco, CA: Wiley.

Lopatto, D. (2003). The essential features of undergraduate research. *CUR Quarterly, 24*, 139–142.

Lopatto, D. (2007). Undergraduate research experiences support science career decisions and active learning. *CBE—Life Sciences Education, 6*(4), 297–306. https://doi.org/10.1187/cbe.07-06-0039

Luo, M., Williams, J. E., & Vieweg, B. (2007). Transitioning transfer students: Interactive factors that influence first-year retention. *College and University*, *83*(2), 8–19.

Meeroff, D., Chamely-Wiik, D., Schneider, K. R., Kwochka, W. R., Frazier, E., Merritt, J., Aldarando-Jefferies, M., and Morrison-Shetlar, A. I. (2019, June). *Work in progress: A transferable model to improve retention and student success in STEM through undergraduate research (NSF LEARN Consortium).* Paper presented at ERM Technical Session 9: Persistence and Retention, 2019 ASEE Annual Conference & Exposition, Tampa Bay, FL.

Mullen, R., & Eimers, M. T. (2002, October). *Understanding transfer success revisited: Transfer students—Who are they and how successful are they?* Paper presented at MidAIR Fall Conference, Early City, MI. https://www.umsystem.edu/ums/fa/ir/transtudent

Nagda, B. A., Gregerman, S. R., Jonides, J., von Hippel, W., & Lerner, J.S., (1998). Undergraduate student-faculty research partnerships affect student retention. *Review of Higher Education, 22*(1), 55–72.

National Center for Education Statistics (n.d). Browse CIP Codes. *Classification of Instructional Programs.* https://nces.ed.gov/ipeds/cipcode/browse.aspx?y=55

National Research Council. (2012). *Community colleges in the evolving STEM education landscape: Summary of a summit*. Washington, DC: National Academies Press.

National Science Foundation, National Center for Science and Engineering Statistics. (2019). Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. *Special Report NSF.* 19-304. Alexandria, VA. Available at https://www.nsf.gov/statistics/wmpd.

Pascarella, E. T., Smart, J. C., & Ethington, C. A. (1986). Long-term persistence of two-year college students. *Research in Higher Education*, *24*(1), 47–71. https://doi.org/10.1007/BF00973742

Payton, F. C. (2004). Making STEM careers more accessible. *Black Issues in Higher Education, 21*(2), 4. Retrieved from https://www.researchgate.net/publication/234751995_Making_STEM_Careers_More_Accessible

Pennington, R. (2006). Rethinking grade transfer shock: Examining its importance in the community college transfer process. *Journal of Applied Research in the Community College*, *14*(1), 19–33.

Pfund, C., Byars-Winston, A., Branchaw, J., Hurtado, S. K. Eagan. (2016). Defining attributes and metrics of effective research mentoring relationships. *AIDS and Behavior* 20(Suppl 2), 238–248. https://doi.org/10.1007/s10461-016-1384-z

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science, 316*, 548–549.

Schneider K. R., & Bickel, A. (2015). Undergraduate research apprenticeship model: Graduate students matched with STEM first-year mentees. *Council on Undergraduate Research Quarterly*, *36*(1), 25–31.

Schneider K. R., Bickel, A., & Morrison-Shetlar, A. I. (2015). Planning and implementing a comprehensive student-centered research program for first-year STEM undergraduates. *Journal of College Science Teaching*, *44*(3), 37–43.

Schneider K. R., Tripp, M., Nair, U., Straney, R., & Lancey, P. (in press). First-year STEM research program facilitates long-term academic success. *Journal of College Science Teaching.*

Scott, T. P., Thigpin, S. S., & Bentz, A.O. (2017). Transfer learning community: Overcoming transfer shock and increasing retention of mathematics and science majors. *Journal of College*

Student Retention, Theory and Practice, 19(3), 300–316. https://doi.org/10.1177/1521025115621919

Seymour, E., Hunter, A., Laursen, S. L., & Deantoni, T. (2004). Establishing the benefits of research experiences for undergraduates: First findings from a three-year study. *Science Education, 88*, 493–534. https://doi.org/10.1002/sce.10131

Townley, G., Katz, J., Wandersoman, A., Skiles, B., Schillaci, M. J., Timmerman, B. E., & Mousseau, A. (2013). Exploring the role of sense of community in the undergraduate transfer student experience. *Journal of Community Psychology 41*(3), 277–290. https://doi.org/10.1002/jcop.21529

Townsend, B. K., & Wilson, K. (2006). A hand hold for a little bit: Factors facilitating the success of community college transfer students to a large research university. *Journal of College Student Development*, *47*(4), 439–456. https://doi.org/10.1353/csd.2006.0052

Tsapogas, J. (2004). *The role of community colleges in the education of recent science and engineering graduates* (Report no. 04-315). Alexandria, VA: National Science Foundation.

Wang, X. (2009). Baccalaureate attainment and college persistence of community college transfer students at four-year institutions. *Research in Higher Education*, *50*, 570–588. https://doi.org/10.1007/s11162-009-9133-z

Zhai, L., & Newcomb, L. H. (2000). *Factors that influence transfer student academic performance and retention* (Report no. 143). Washington, DC: U.S. Department of Education.

Zilvinskis, J., & Dumford, A. D. (2018). The relationship between transfer student status, student engagement, and high-impact practice participation. *Community College Review*, *46*(4), 368–387. https://doi.org/10.1177/0091552118781495

Zydney, A., Bennet, J. S., Shahid, A., & Bauer, K. W. (2002). Impact of undergraduate research experience in engineering. *The Research Journal for Engineering Education*, *91*(2), 151–157. https://doi.org/10.1002/j.2168-9830.2002.tb00687.x

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 225-240.
doi: 10.14434/josotl.v21i1.30359

QEP is HIP: A Case Study Implementing an Institution-Wide Undergraduate Research Community of Inquiry for a Small Private College Setting

Melissa N. Tingle
Piedmont College
mtingle@piedmont.edu

Julia M. Schmitz
Piedmont College
jschmitz@piedmont.edu

Perry Rettig
Piedmont College
prettig@piedmont.edu

Abstract: Piedmont College's quality enhancement plan (QEP) emphasizes a developmental and progressive integration of high-impact practices (HIPs) into the academic and social fabric of the institution. The QEP is HIP initiative provides students with multiple opportunities to deepen learning and leadership skills, which leads to improvements in student success, persistence, and retention. However, the institution grappled with how to effectively engage students in effective, meaningful research-based experiences. During the 2nd year of its QEP implementation, a campus-wide undergraduate research symposium was launched to showcase students' research and creative inquiry in an effort to (a) gain full institutional participation in this crucial HIP and (b) offer the underserved student population (defined as ethnic minority, Pell-eligible, and first-generation students) an opportunity to participate in professional socialization and experience faculty mentorship. This case study shows the initial influences of this HIP on student success (in terms of grade point average [GPA]), students' perceptions of their own learning, students' persistence (measured with the Grit Scale), and retention from the 2018–2019 to the 2019–2020 academic year. Specifically, this study compared students who presented their research at the undergraduate research symposium to students who did not. While the immediate influence of this HIP on student persistence/perseverance (grit scores) remains undetermined, the retention rates and GPA appear to have been higher for students who presented, in both the dominant and underserved populations. Furthermore, students reported an increase in perceptions of their own learning. These findings are significant and affirm that undergraduate research communities can be considered a HIP for students, including those of underserved populations.
Keywords: quality enhancement plan (QEP), high-impact practice, undergraduate research, symposium

Institutions of higher learning across the nation are focusing on increasing student retention and persistence to graduation by integrating high-impact practices (HIPs), particularly undergraduate research. Undergraduate research, a form of experiential learning, connects key concepts and questions with students' early and active involvement in systematic investigation and research (Kuh, 2008). Effectively integrating a culture of research across different departments and programs within an institution, however, is challenging. "Promoting a culture of research across campus requires some form of institutional consensus and a common focus to help achieve this objective" (Nyhus, Cole, Yeterian, & Firmage, 2002, p. 16). Along with this focus comes the problem of implementation: While many institutions have focused on undergraduate research experiences (UREs) at the course and programmatic levels in recent years (Fechheimer, Webber, & Kleiber, 2011), resources must also be dedicated to developing an institution-wide culture that showcases these high-impact research practices outside the classroom. Furthermore, special care must be taken in the creation of this undergraduate research community of inquiry to engage historically underserved student populations, increase students' perceptions of their own learning, and encourage a "cross-pollination" approach to research between the disciplines and fields within an institution (Dhand, Luke, Carothers, & Evanoff, 2016).

Background

This case study focuses on a small private college in northeast Georgia that is a member of the Southern Association of Colleges and Schools Commission on Colleges. Recently tasked with developing a quality enhancement plan (QEP) to implement institution-wide HIPs, the college chose to center its efforts on integrating undergraduate research and creative inquiry into the academic and social fabric of the institution. In its first year, the "QEP is HIP" initiative provided students and faculty with multiple funding opportunities to deepen learning and research skills; however, the institution grappled with how to effectively engage students across disciplines in effective, meaningful, research-based experiences to realize tangible improvements in student success, persistence, and retention (Bonet & Walters, 2016; Kelly, 2011). While departments throughout the college had already experienced some success with integrating UREs at the course and programmatic levels, a collective undergraduate research community was needed to offer students the opportunity to display and discuss research outside the traditional classroom, receive interdisciplinary feedback, and develop an institutional culture of transformational research experiences, particularly aimed at its underserved student population.

In response to this problem, during the 2nd year (2018–2019) of its QEP implementation, the college launched a campus-wide undergraduate research symposium to showcase students' research and creative inquiry. This was in an effort to (a) gain full institutional participation in this crucial HIP and (b) offer the underserved student population (defined as ethnic minority, Pell-eligible, and first-generation students) an opportunity to participate in professional socialization and experience faculty mentorship that provides "leadership to their own learning and the learning of others" (Camacho, Holmes, & Wirkus, 2015, p. 65). As part of the symposium implementation process, the QEP director, along with a specialized symposium steering committee, created a planning document that mapped out a timeline of development and execution.

Timeline and Implementation

The symposium steering committee was created in January 2018 with representatives from the four schools at Piedmont College (Arts & Sciences, Business, Education, and Nursing & Health Sciences), as well as a communications director and experiential learning director. The steering committee met to formulate initial symposium plans with a target launch date of April 2019. Four months later, the group traveled to a peer southeastern institution to experience its undergraduate research day firsthand. This helped the committee formulate ideas regarding the logistics and delivery of a similar event as well as gave individuals the opportunity to sit down with the research day organizers and ask questions to help frame their own research day. Later that month, an additional communications committee was created, which settled on the name of the undergraduate research day to begin the branding and promotion process, led by the communications director from the symposium steering committee. Last, a QEP assessment committee, which had been created as part of the overall QEP initiative, was tasked with developing direct and indirect assessment tools, so that the relationship between symposium participation, retention, engagement, and other HIP outcomes could be assessed.

In fall 2018, a renowned research professor was invited from a different peer institution to generate interest in the research day. She presented to students and faculty in various sessions and conducted small groups for students to develop ideas for a research question and then formulate what type of research they would need to complete to answer that research question, which they then presented to the larger group. This visit was integral to preparations for the research day because it helped prime students and faculty to consider an institutional research symposium and prompted them to "think outside the box" for types of projects they could develop from current course content and assignments. The symposium steering committee also launched an online application process during her visit, so students could begin submitting project abstracts and proposals. Additionally, information was made available to faculty about the accessibility of QEP research grants to help fund research proposals. The steering committee concurrently worked with the academic deans as well as heads of different key cocurricular projects (e.g., Summer Travel Study, Alternate Spring Break, Experiential Learning), to develop participation goals for the number of students they would enlist from each specific area. This encouraged collaboration between the steering committee and the various institutional heads to achieve a higher percentage of participation and overall buy-in. Additionally, the steering committee worked with the vice-president for academic affairs to arrange for all afternoon classes to convene at the half-day event, to increase attendance numbers and support for student participants.

The online application process concluded at the end of February 2019, and students were notified in class (by their professor) the following month with an embossed recognition card announcing their selection. The reason for this was threefold: (1) The student received public acknowledgement of this achievement they could archive in their professional portfolio; (2) it offered the advising professor an opportunity to talk about the importance of participating in the research day to support their fellow student participants; and (3) it created a subtle air of prestige surrounding the event.

Two weeks before the scheduled symposium event, the QEP assessment committee presented digital rubrics (adapted from the Association of American Colleges and Universities' [AAC&U's] Integrative Learning VALUE Rubric) and procedures for assessing presentations and research posters. The communications committee also selected a few presentations to highlight ahead of the event to increase the interest of students attending the event. The steering committee procured volunteers from faculty and staff to serve as assessors for each presentation and poster. Student volunteers were recruited to be runners, timekeepers, and welcome -table workers to ensure all participants were checked in for the event.

On the event day, each student who participated received a certificate and an official event shirt during check-in. The institutional advancement media team was on hand to take pictures and create a video that was released the following day on various institutional web and social media outlets. Student influencers were also selected to take over social media and post in real time about the event to allow parents, alumni, and prospective students who were unable to attend the opportunity to feel included and connected to the event. The student-run radio station ran a live on-site broadcast throughout the day and interviewed members of the committee, as well as various student participants, so they could discuss their event roles and create a buzz of excitement.

After the event concluded, several debriefing processes took place. The assessment committee collected all assessment data from the digital rubrics and merged it into the primary QEP database. The communications and steering committees convened the week following the event to discuss the anecdotal feedback from faculty, students, and administrators as well as compile a list of logistical improvements to consider for the next symposium. Discussions about the level of academic rigor of student presentations ensued, and a recommendation for additional library resources and research workshops was offered. Additionally, a feature article was written by the Office of Institutional Advancement for its Academic Showcase Journal, which was then delivered to alumni, parents, faculty, staff, and current students, providing an official post-event record.

Literature Review

The idea for this institution's undergraduate research day originated from the AAC&U's LEAP (Liberal Education and America's Promise) initiative, developed in 2005. One aspect of this initiative is the inclusion of HIPs as identified by George Kuh (2008), who has advocated for institution-wide UREs. The AAC&U (2020) noted that HIPs increase rates of student retention and engagement. Additionally, "high impact practices have a pronounced effect on the experiences of underserved students" (Finley & McNair, 2013, p. 13). The institution was specifically interested in building upon ideas presented in extant URE literature to increase student persistence, retention, engagement, and overall academic success.

UREs and Student Persistence/Retention

Undergraduate research is an HIP that leads to better student achievement, retention, and persistence (Bonet & Walters, 2016; Craney et al., 2011). It has a pronounced impact on underrepresented populations, leads to deeper learning, and can build a professional community through mentoring (Bonet & Walters, 2016; Kelly, 2011). While undergraduate research projects have typically been employed within the "hard sciences," Kuh (2008) recognized that opportunities to engage in undergraduate research can, and increasingly do, exist in all academic disciplines. According to Kuh (2008), the goal of undergraduate research is to "involve students with actively contested questions, empirical observations, cutting-edge technologies, and the sense of excitement that comes from working to answer important questions" (p. 10). Cooper et al. (2019) also focused on the benefits and value of being involved in undergraduate research. They found that students persisted with their research because they "perceived they were learning important skills or knowledge and because they perceived it was important for their career goals" (Cooper et al., 2019, p. 19). Tinto (1975) studied the reasons students leave college early and found that those who persisted were better integrated into formal classroom experiences, such as undergraduate research, and interacted with faculty at a higher rate. Furthermore, he argued that to persist in their studies, students require not just formal and informal classroom experiences but also integration into the formal social systems of an institution (Tinto, 1975).

UREs and Student Engagement/Perceptions of Learning

Student involvement in undergraduate research, with both faculty and peers, has a wide-ranging impact on student engagement and perceptions of their own learning. Astin (1999) noted that students who invest significant time and energy into being actively engaged within their academic experiences are more likely to persist. Kinner and Lord (2018) found that upper level students who had high levels of engagement in UREs had significantly higher gains in "feeling like a scientist," creativity, working extra hours, and feeling part of a scientific community. With respect to working with faculty and other student mentors, they also found that "research mentors have the opportunity to provide technical, intellectual, and personal/emotional support, as well as professional socialization for students" (Kinner & Lord, 2018, p. 19).

Echoing this sense of professional community and connection, Camacho et al. (2015) studied the Applied Mathematical Sciences Summer Institute (AMSSI) to discover what barriers existed between underserved populations and UREs. AMSSI was a program that focused on providing mathematical research experiences for women, underrepresented minorities, and individuals from small teaching institutions who might not have opportunities to do research otherwise. AMSSI used a mentoring model focused on "creating the learning community in which all individuals provided leadership to their own learning and the learning of others" (p. 65). Further, "presenting helped the students reinforce what they had learned, better understand their research problems, think on their feet, practice their oral presentation skills, and generate value" (p. 68). Russell, Hancock, and McCullough (2007) found that undergraduate research outcomes in minority groups showed increased understanding, confidence, and awareness about the rigors of graduate school. Barlow and Villarejo (2004) found that undergraduate research programs reduced attrition and greatly increased academic engagement in biological sciences, as well as the odds of positive graduation outcomes in minority student populations. Program participants were also more likely to pursue graduate study than were university graduates overall.

UREs and Student Success

Opportunities for UREs offer students numerous benefits, including increased self-confidence, career preparation, enhanced mentoring relationships, the development of transferable skills, networking opportunities, and collaboration skills (Faulconer & Gruss, 2019). Bowman and Holmes (2018) explored the effect of 1st-year participation in research experiences on undergraduate grade point average (GPA), which showed that overall, 1st-year undergraduate research participation was positively related to 4th-year undergraduate GPA as well as 1st-year university satisfaction. Interestingly, 1st-year participation in this experience did not have a significant effect on students' 1st-year GPA but rather an apparent delayed effect on 4th-year GPA. Fechheimer et al. (2011) found that students involved in undergraduate research (all students taking one or more directed-research courses) had a significantly higher GPA compared with students who did not participate in undergraduate research for all students, as well as for males and females separately. Harde and Haave (2012) argued that, typically, access to undergraduate research has been limited to students with superior GPAs. Few studies, however, have documented the impact on students in general with lower grades or whether the impact of undergraduate research on GPA is observable prior to graduation.

Research Questions

The institution currently under focus in this case study already had moderately strong UREs at the course and programmatic levels. The purpose of this case study was to examine this institution's struggle with creating a campus-wide community of research and inquiry. By creating the undergraduate research symposium, researchers hoped to find answers to the following research questions:

1. Will students who participated in an undergraduate research symposium be retained at higher rates from year to year than students who did not?
2. How does cumulative GPA differ in students who participated in an undergraduate research symposium versus students who did not?
3. How do rates of persistence/perseverance differ among students from various underserved and traditionally advantaged groups who presented in the symposium? Among nonparticipants?
4. How does participation in an undergraduate research symposium affect students' perceptions of their own learning?

Method

We used a mixed methods approach to analyze how students' participation ($N = 162$) in an institution-wide undergraduate research symposium affected students' perceptions of their own learning, and if the integration of this event into the academic and social fabric of the college led to improvements in student success as represented by cumulative GPAs as well as, persistence/perseverance, and retention rates.

Conceptual Model

Astin's (1991) Input-Environment-Output model was the conceptual model that influenced the QEP Is HIP initiative to capture student data in a way that demonstrates an understanding of student qualities and characteristics upon their entry into the institution, the nature of the HIPs that potentially influence their learning and social environments, and their qualities and characteristics as they exit the institution, to be able to fully evaluate its effectiveness. Astin (1999) also created five basic assumptions about student involvement, one of which emphasizes the idea that what a student gains from being involved in a pursuit is directly related to the student's level of intensity and extent of involvement, in terms of both quality and quantity. Likewise, academic performance is directly correlated with the level of a student's involvement in various pursuits. To that end, we acknowledge that the variations in success and achievement that may have occurred during the time period being studied cannot necessarily be attributed directly to the impact of the QEP is HIP initiative. Other factors such as personal development and the environment outside of the initiative (and institution in general) may have also created changes that could influence measures of student success, persistence/perseverance, students' perceptions of their own learning, and retention. Nonetheless, this study's purpose is to explore the idea that its institution-wide URE is a contributing influence on these measures.

Participants and Procedures

Since the initiation of the institution's QEP in the fall of 2017, data have been collected and analyzed from three cohorts (2017–2018, 2018–2019, 2019–2020), capturing students ($N = 1{,}095$) who entered as new students (1st-years and transfers) in each fall semester under its implementation period (Table 1). The student symposium participants who self-selected to present in the 2019 inaugural research day were an amalgamation of the fall 2017 and fall 2018 cohorts, specifically. We designated a control group from the 2016–2017 cohort (before the QEP was introduced),but the data sets were incomplete and rendered unusable. Therefore, only descriptive statistics were used to ascertain if a change occurred between cohort groups, and the label "nonsymposium" was used to delineate students from the fall 2017 and fall 2018 cohorts who did not self-select to present. Furthermore, the quantitative data (i.e., success, persistence/perseverance, and retention) used in this study are captured year-round from various sources by the QEP assessment committee as part of the initiative. Two phases of qualitative measures were implemented pre- and postsymposium, so that researchers could capture students' perceptions of their own learning.

Table 1. Quality enhancement plan cohort demographics.

Variable	Cohort		
	2017–2018	2018–2019	2019–2020
Total number	351	338	406
Entering 1st-years	272	247	277
Transfers	79	91	129
Male	127	137	164
Female	224	201	242
Commuters	86	85	130
Residential	265	253	276
African American	49	39	60
Hispanic and Latino/Latina	25	13	2
Multiracial	12	15	2
Pell eligible	154	154	189

Data and Identity Protections

In January 2018, a proposal was submitted to the Institutional Review Board (IRB) for the QEP is HIP initiative in anticipation of tracking measures related to the symposium event. The principal and coprincipal investigators completed their training with the Collaborative Institutional Training Initiative prior to submission of the application. IRB approval was granted in February 2018, which allowed the investigators to track cohort GPA, underserved status, participation in HIPs, and Grit Scale (Duckworth, Peterson, Matthews, & Kelly, 2007) scores. In February 2020, an addendum was approved to create postevent focus groups of students who had presented in the symposium, 10 months later. Students were tracked using their student ID numbers so that data could be collected confidentially from the numerous databases across the college.

Measures/Data Sources

Cumulative GPA. Undergraduate cumulative GPA was collected for each student from the registrar's office at the end of each semester.

Retention data. Retention data were collected for each student from the Institutional Effectiveness and Research office at the end of each semester.

Grit (persistence/perseverance) scores. According to Duckworth et al. (2007), showing grit involves working vigorously toward challenges and maintaining effort and interest over years despite failure and adversity. Intertwined with grit is the concept of persistence or perseverance, or the voluntary continuation of a goal-directed action despite barriers or difficulties (Peterson & Seligman, 2004). As part of the QEP initiative, the Grit Survey, taken directly from Duckworth's 12-item Grit Scale, is administered college-wide during a student's 1st and 4th years.

Postpresentation survey. For Phase 1 of the QEP, a simple follow-up online questionnaire was sent to the symposium participants ($N = 162$) from the 2017–2018 and 2018–2019 cohorts following the symposium event. The questionnaire asked one open-ended question, "Did this experience increase your interest in research, and if so, how?

Ten-month postpresentation focus groups. For Phase 2, the researchers conducted a series of focus groups over a 2-day period, 10 months after the first annual symposium event, which also fell 6 weeks before the second annual symposium event. Participants had been recently exposed to symposium promotional materials and events around campus, and the topic was fresh in their minds. The QEP director and QEP Assessment Committee chair used institutional email to invite all previous symposium participants to participate in a focus group about their symposium experiences. Eighteen student participants were recruited and divided into four focus groups. Each focus group was asked the following eight questions:

1. What made you want to participate in undergraduate research or creative inquiry?
2. Did this experience increase your interest in research or creative work? How?
3. Have you been able to apply any research skills learned from this experience to your courses?
4. Did this experience have any effect on your communication skills? How?
5. Did this experience have any effect on your problem-solving skills? How?
6. Has this experience prepared you for your career and/or for graduate school? How?
7. Did someone serve as a mentor to you during this experience? If so, in what capacity and how did this help?
8. Are you or will you serve as a mentor to others who might want to participate in undergraduate research/creative inquiry? How would you help?

Results

Influence on Student Retention

The most striking result of this case study is the percentage of symposium participants who were retained from the 2018–2019 to the 2019–2020 academic year. In this study, the term *retained* was also used to indicate students who persisted to graduation. Students who presented in the undergraduate research symposium event (n = 162) were shown to be 15% more likely to graduate or be retained than those who did not (n = 555). The data in Figure 1 represents a subset of the total cohort population (n = 717).

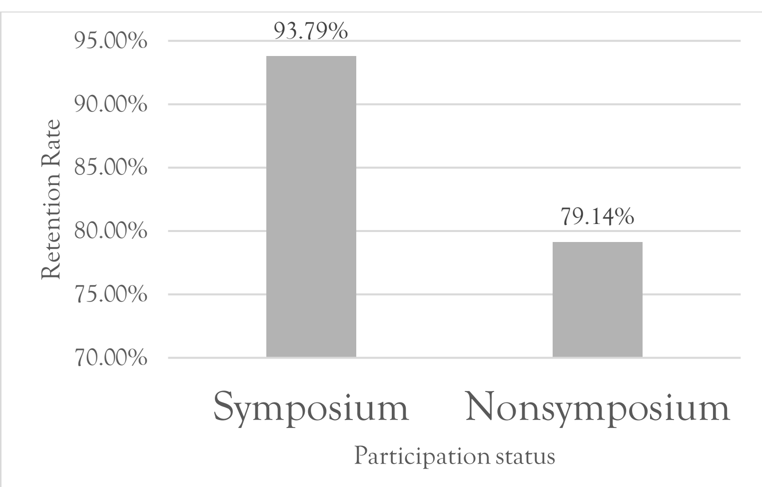

Figure 1. Total retention from the 2018–2019 to the 2019–2020 academic year. Symposium participants (n = 162) retained at a higher rate than nonsymposium participants (n = 555).

As shown in Figure 2, when we examined the underserved populations to see what overall influence presenting undergraduate research at the symposium had, students who participated had a higher retention rate than nonparticipants regardless of their minority status, Pell eligibility, or first-generation status. The highest difference in retention rate (22%) was for minority students (*n* = 144), followed by a difference of 11% for white students, 9% for first-generation students (*n* = 516) and 9% for the Pell-eligible students (*n* = 602). This again shows an increase in the rate of retention of underserved students who participate in a URE over those who do not. Students who did not self-report their ethnicity or first-generation status were not included in this data set.

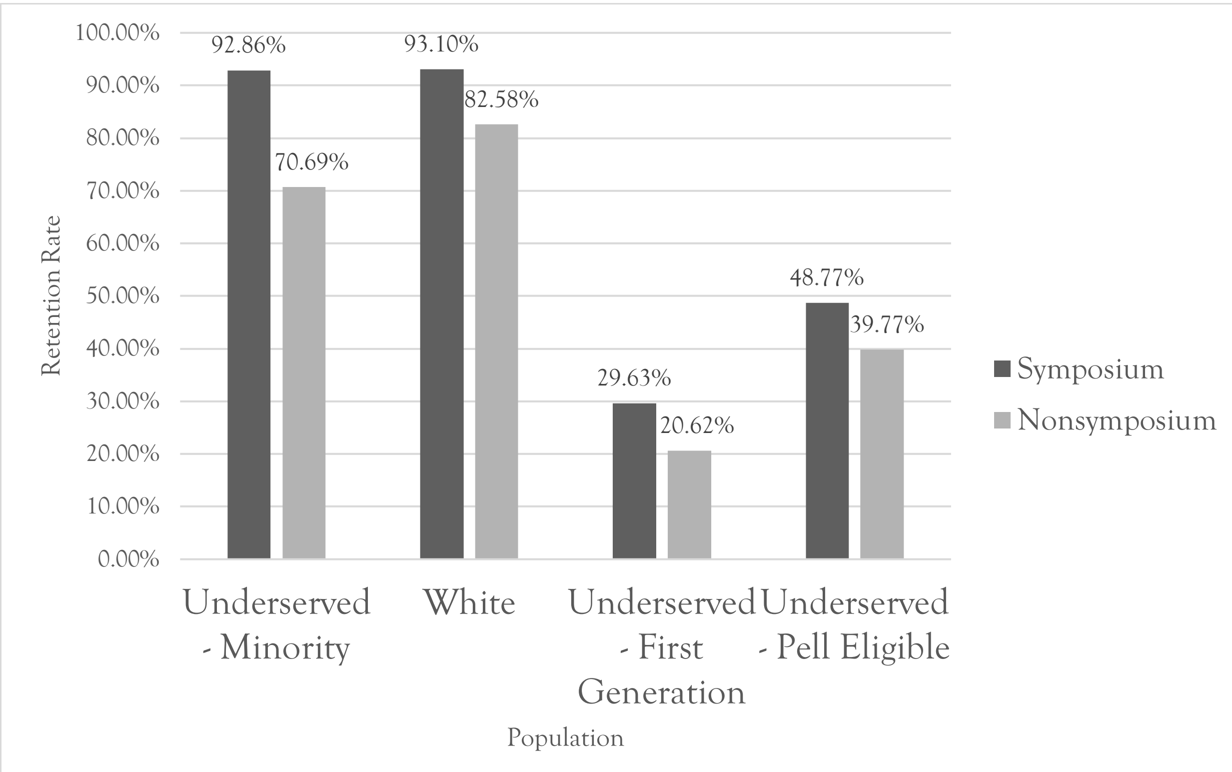

Figure 2. Retention rates of student populations disaggregated. Differences in retention rates between underserved and traditionally advantaged groups.

Influence on Student Success (GPA)

To determine if the symposium had any possible influence on student success, the researchers averaged the cumulative GPA of all symposium participants versus nonparticipants for the semester prior to the symposium as well as the semester after the symposium (*N* = 627). Students who participated in the symposium (*n* = 162) had a slightly higher cumulative GPA one semester later than students who did not (*n* = 555, as shown in Figure 3. Cumulative GPA for students who persisted to graduation after the symposium was reflected by reporting the cumulative GPA of their last semester in attendance.

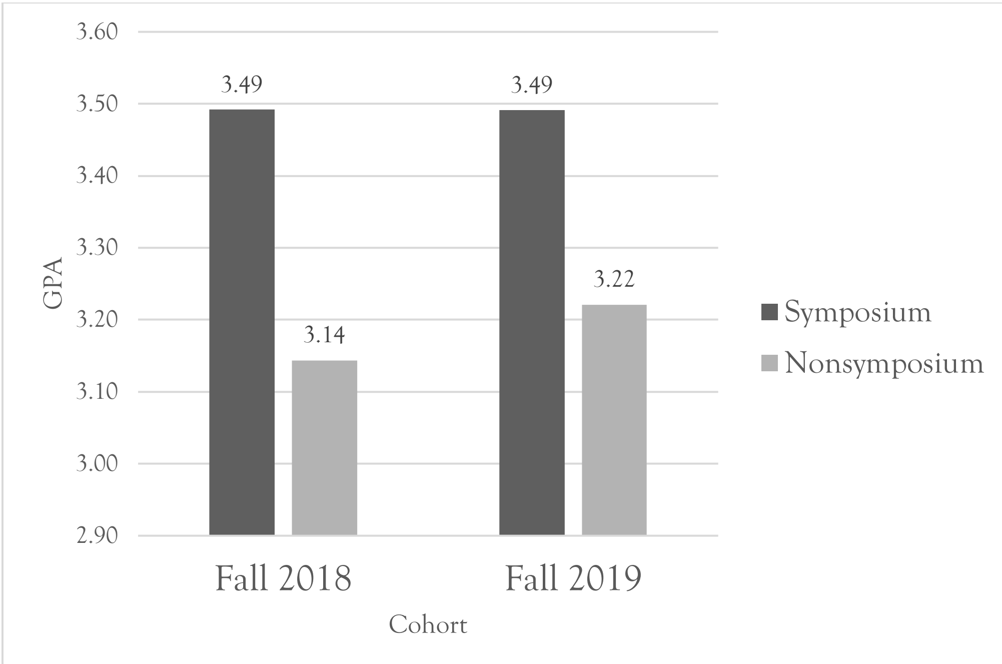

Figure 3. Cumulative grade point average (GPA) of participants and nonparticipants. Symposium participants averaged a higher GPA than nonparticipants.

Influence on Student Persistence/Perseverance

Grit scores were collected from students during their first semester at the institution and disaggregated to determine the influence on student persistence/perseverance ($N = 280$). Surprisingly, there was no recorded difference in the grit score of students who participated in the symposium ($n = 162$) versus those who did not ($n = 118$; Figure 4). However, this data set is incomplete: Students who entered prior to fall 2017, most likely listed as a junior or senior during the semester of the symposium, were not administered the Grit Survey, because it was not yet implemented as part of the QEP assessment plan. As shown in Table 2, 74% of symposium participants were recorded as juniors and seniors ($n = 120$).

Table 2. 2019 Symposium participants.

Total number	162
Retained/graduated	155
1st-year	6
Sophomore	29
Junior	41
Senior	79
Unknown	7
Underserved populations	
Minority	25
Pell eligible	79
First generation	48

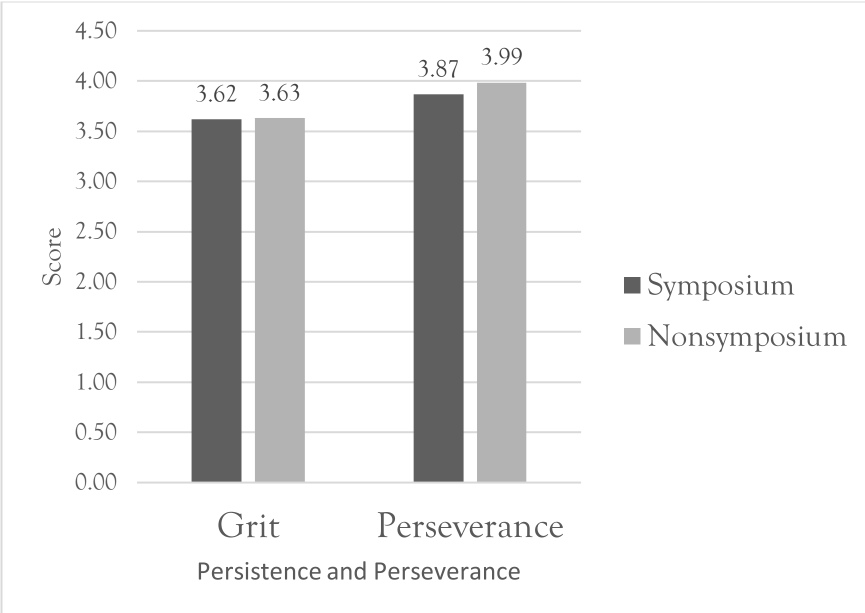

Figure 4. Student grit scores. No gains reported.

Influence on Student Perceptions of Learning

Phase 1. As part of the Phase 1 effort to determine what influence, if any, participating in the symposium had on students' own perceptions of learning, the researchers used the institution's own mobile app technology (campus cloud service) as a way to track participants and attendees as well as create a way to gain immediate feedback after the event's conclusion from a participant's perspective. The app offered a 1–5 (low to high) star rating system for the event and asked one open-ended question: "Did this experience increase your interest in research and if so, how?" Of all participants (N = 162), 158 offered either 4 or 5 stars, and three offered qualitative feedback. These participants' remarks included: "Great first year! Looking forward to even more participation next year now that we've seen what it's like!" and "Yes it increased my interest! I thought it was very interesting how these students went through the whole research process and presented their results, just as I did."

Phase 2. Based on perceptions of learning outcomes as reported by participants in the 10-month post event focus groups (N = 18 participants), four major themes emerged from among the recorded responses. The numbers in parentheses express the percentage of the total number of student respondents who reported these outcomes as gains:

1. Increased interest in research (83%)
2. Strengthened communication skills (100%)
3. Increased preparation for career/graduate school (77%)
4. Interdisciplinary exposure (61%)

The following comment is typical and reflects the general tone of the responses that point to the increased interest in research that was gained by participating in the event:

> I think it was a really good introduction into the world of research. I guess, presenting yourself as a professional academic person, who's doing research in these fields, and then presenting what you've learned and your ideas so far. I think it was a really good

> steppingstone like that had never occurred to me as something that I could do in my professional career. Now having that experience, I've thought more about it. I've thought about possible research topics.

Another participant noted, "I think for me it's encouraged me to do research in other parts of my life…. We went to a conference a month ago. Now I've started to think about maybe presenting at that conference and doing something in that field."

Interestingly, some students reflected that the experience was an expansion and continuation of their oral communication skills learned in earlier semesters. As one student put it:

> I think, personally, I've done a lot of individual presentations, but I think this was my first time doing a group presentation, with a group made up of 12 people. It came to a point that we had to understand how we communicate within the team. How do we communicate to the external body? How do you switch when you communicate, and who is better at doing what? I think those skills really come out in communication as well. It's not the same thing as how you go and talk to a crowd. It's more like how do you prepare to talk to a crowd. That's something we learned, and it was a soft skill that we'll be using again.

When asked if participating had any influence on their preparation for careers or graduate school, many respondents commented that their leadership skills, soft skills, and preparation for graduate school rigor were increased. However, one student conveyed an epiphanic experience in self-awareness:

> In terms of graduate school, I was a sophomore when I gave my presentation last year, and now I'm a junior, and I think [this] experience: it kind of made graduate school a reality for me. It was like, "Oh, I should probably start thinking about this. It's coming up." It opened that door for me, and as a result, I've thought about it a lot more. I've come to valuable conclusions about what I actually want to do with my life. I had to harshly ask myself, 'Okay, do I want to present on Philosophy and Art History for the rest of my life?' Turns out, the answer is no. Although it was great, and I find those things interesting, I don't think that's what I want to do for the rest of my life. So, learning that you don't want to do something is a valuable experience.

There were additional interesting outcomes that were outside the identified themes, including the importance of mentorship in the learning process, and perhaps most surprisingly, the emergence of an awareness of the work being done in other disciplines at the institution. As one student commented, "I think it's important. I know a lot of students here at the school; you get cliques of people in their major. This kind of thing opens up a lot awareness for others' areas of specialty."

Discussion

The purpose of this case study was to examine whether participation in an institution-wide undergraduate research symposium could help promote student engagement in research (particularly within underserved populations), retain students at higher rates, increase average GPA, and better prepare students for the rigors of professional careers/graduate school by increasing their persistence (grit) and perceptions of their own learning. In considering the findings, it is important to note that all UREs, whether at the course, program, or institutional level, are interrelated. Meaning, these findings are reflections of not just the event itself but also the culmination of student research, coursework, and projects leading up to the event. Additionally, it is important to point out that although this study did find that participation might have a positive influence on retention and GPA, these are not the only factors that impact these areas. While there was no apparent connection between the symposium participation and persistence, students did report an increased interest in research, strengthened communication skills, greater preparation for the rigors of professional careers/graduate school, and increased interdisciplinary exposure.

Increased Interest in Research

One common theme that emerged from the postsymposium focus groups was increased interest in research. This result and theme were what QEP facilitators hoped to gain from the symposium. The institution had previously maintained strong research opportunities for seniors in the form of required capstones, but this symposium allowed faculty the opportunity to redesign courses to incorporate research into 1st- and 2nd-year courses. This also allowed students to "own" more of their learning and consider their coursework in a broader context. Some students saw participation as a stepping-stone and began to consider other opportunities for research. Others seemed to understand the connections between critical thinking, practical research skills, and communicating to a wider audience.

Strengthened Communication Skills

Frequently, students remarked on how participating in the symposium strengthened their communication skills and teamwork skills, which affirms Camacho et al.'s (2015) assertions that "presenting helped the students reinforce what they had learned, better understand their research problems, think on their feet, practice their oral presentation skills, and generate value" (p. 68). Because the institution does offer public speaking as part of the general education curriculum, many connected the soft skills acquired in that course with the demands of presenting in a larger forum. A few students commented on the experience as confidence building and associated presenting at the symposium with presenting their own work in a more professional or graduate school context.

Preparation for Career/Graduate School

A third theme that emerged was that the symposium experience had elements students associated with career/graduate school preparation. Students realized how important it was to develop their leadership skills and soft skills in preparation for their future career path. This affirms Russell et al.'s (2007) findings that undergraduate research outcomes lead to increased understanding, confidence, and awareness about the rigors of graduate school. Surprisingly, two student participants observed that graduate school is a real possibility, and this experience allowed them to make valuable decisions about their future career paths that probably would not have happened if they had not presented. This affirms Barlow and Villarejo's (2007) findings that URE participants are more likely to have a higher GPA as well as continue to graduate school. These students also remarked that they enjoyed the mentoring they received from working closely with a faculty member in their field of study. While determining the relationship between the symposium and mentorship was not an express goal of this study, this does help support Kinner and Lord's (2018) findings that "research mentors have the opportunity to provide technical, intellectual, and personal/emotional support, as well as professional socialization for students" (p. 19).

Interdisciplinary Exposure

Building upon an established culture acknowledging the importance of undergraduate research at the course and programmatic levels, Phase 2 of this study added the additional reported theme of a "cross-pollination" approach—as described by Craney et al. (2011)—among disciplines of the entire college. This interdisciplinary approach was encouraged by the undergraduate research symposium where students across the college were able to observe fellow students' presentations from all disciplines. While interdisciplinary exposure was not an explicit focus of the QEP steering committee, focus-group participants did express a positive influence. This suggests future efforts of the QEP initiative should be more purposeful in providing opportunities for cross-pollination experiences to undergraduate students across the campus.

Recommendations for Future Research

Developing an institutional undergraduate research community of inquiry was a central theme of the QEP initiative in this study. Piedmont College considers itself a small liberal arts teaching college, as opposed to a research university, making this endeavor even more significant. Although the students are regularly exposed to research at the senior level through a capstone project in all disciplines, the goal was to infuse research into lower level courses to build a foundation of research and inquiry. Through the course of this study, the data indicated there may be higher retention rates and GPAs of symposium participants from one year to the next, regardless of ethnicity, Pell eligibility, or first-generation status. Of course, the inverse could potentially be true: Students with higher retention and GPAs are more likely to participate in the symposium. The next steps will include isolating these data points and developing a longitudinal study that determines causation when controlling for extraneous factors.

Limitations

During this study, some limitations were observed that echo Brownell and Swaner's (2009) concerns about assessing the impact of HIPs on student learning, despite the advantages of implementing these strategies. They contended that when measuring HIPs, it is " impossible to generalize … or to identify which program component leads to a particular outcome" because of the various ways HIPs can be implemented at different institutions (p. 3). The same limitation applies to this particular case study, because there are numerous factors that can influence a student's matriculation, retention, and success.

Another limitation was the lack of complete data sets. The institution's Grit Survey was not administered until the fall of 2017 during the 1st year of the QEP initiative. As a result, most symposium participants had not completed it, so the symposium's influence on persistence was difficult to determine. Additionally, some of the collected data on the underserved populations relied on students self-reporting their status; thus it was difficult to get a complete picture of the ethnic minority or first-generation status of all three cohorts. Because of these incomplete data sets, the researchers were unable to establish a control group so that inferential statistics could be conducted. Last, the researchers realized when conducting the focus groups that the question about student perceptions of problem-solving skills did not translate well to the participants. They answered the question with problem-solving skills they had to use on the day of the presentation (e.g., to deal with faulty technology, time management issues, etc.) and did not delve into any skills developed during their research. This question will be reworded for future focus groups.

Conclusion

Through the course of this study and the postsymposium evaluation, some positive institutional outcomes were illuminated. Just before the submission of this article, the QEP steering committee reported a doubling (*N* = 344) in the number of student participants and faculty mentors committed to presenting at the 2020 symposium. One of the four schools realized, after viewing the work of other schools at the symposium, that they did not have a strong research component in their major. As a result, they are working toward creating a more research-oriented capstone experience for their students, as well as examining how to integrate these experiences into their 1st- and 2nd-year courses. Furthermore, one department has not only developed a strong faculty/student mentorship as a result of this symposium experience but is now expanding this idea to allow the students to mentor peers from lower classes during their research. There was also a notable increase in conversation from various departmental faculty about exploring new ways to engage students, especially 1st- and 2nd-year students, in UREs. In sum, the main findings of this study aligned with principles of encouraging active participation in undergraduate research to create an institution-wide community of inquiry, meaningful contact between students and faculty, and a commitment to engaging in a culture of research across all disciplines.

References

American Association of Colleges and Universities. (2020). *High-impact educational practices. A brief overview*. https://www.aacu.org/leap/hips.

Astin, A. (1991). *Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education.* New York, NY: MacMillan.

Astin, A. W. (1999). Student involvement: A developmental theory for higher education. *Journal of College Student Development, 40*(5), 518–529.

Barlow, A. E., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching, 41,* 861–-881. https://doi.org/10.1002/tea.20029

Bonet, G., & Walters, B. (2016). High impact practices: Student engagement and retention. *College Student Journal, 50*(2), 224–235.

Bowman, N. A., & Holmes, J. M. (2018). Getting off to a good start? First-year undergraduate research experiences and student outcomes. *Higher Education*, *76*(1), 17–33. https://doi.org/10.1007/s10734-017-0191-4

Brownell, J. E., & Swaner, L. E. (2009). High-impact practices: Applying the learning outcomes of literature to the development of successful campus programs. *Peer Review 11*(2), 26–30.

Camacho, E., Holmes, R., & Wirkus, S. (2015). Transforming the undergraduate research experience through sustained mentoring: Creating a strong support network and a collaborative learning environment. *New Directions for Higher Education,* 63–73.

Cooper, K., Gin, L., Akeeh, B., Clark, C., Hunter, J., Roderick, T., ... Brownell, S. (2019). Factors that predict life sciences student persistence in undergraduate research experiences. *PLoS ONE, 14*(8), e0220186. https://doi.org/10.1371/journal.pone.0220186

Craney, C., McKay, T., Mazzeo, A., Morris, J., Prigodich, C., & de Groot, R. (2011). Cross-discipline perceptions of the undergraduate research experience. *The Journal of Higher Education, 82*(1), 92–113. https://doi.org/10.1080/00221546.2011.11779086

Dhand, A., Luke, D. A., Carothers, B. J., & Evanoff, B. A. (2016). Academic cross-pollination: The role of disciplinary affiliation in research collaboration. *PLoS ONE*, *11*(1), e0145916. https://doi.org/10.1371/journal.pone.0145916

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). *Grit Scale*. PsycTESTS.

Faulconer, E. K., & Gruss, A. B. (2019). UNDERGRADUATE RESEARCH FOR ONLINE STUDENTS. *Quarterly Review of Distance Education*, *20*(3), 45.

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How well do undergraduate research programs promote engagement and success of students? *CBE Life Sciences Education, 10*(2), 156–163. https://doi.org/10.1187/cbe.10-10-0130

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

Harde, R., & Haave, N. (2012). Wider horizons: Fostering a culture of undergraduate research. *Collected Essays on Learning and Teaching, 5*, 39–43.

Kelly, R. (2011). Implementing high-impact learning practices that improve retention. *Recruitment and Retention in Higher Education, 25*(12), 6–7.

Kinner, D., & Lord, M. (2018). Student-perceived gains in collaborative, course-based undergraduate research experiences in the geosciences. *Journal of College Science Teaching, 48*(2), 48–58. https://doi.org/10.2505/4/jcst18_048_02_48

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

Nyhus, P., Cole, F., Yeterian, E., & Firmage, D. (2002). Enhancing the integration of research and education using an interdisciplinary undergraduate research symposium. *Council on Undergraduate Research Quarterly, 33,* 16–23.

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues : A handbook and classification.* Washington, DC: American Psychological Association.

Russell, S., Hancock, M., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science, 316*(5824), 548–549. https://doi.org/10.1126/science.1140384

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45*(1), 89–125. https://doi.org/10.3102/00346543045001089

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 241-286.
doi: 10.14434/josotl.v21i1.30430

Supporting Biomedical Research Training for Historically Underrepresented Undergraduates Using Interprofessional, Nonformal Education Structures

Lisa K. Marriott*
Oregon Health & Science University

Aaron Raz Link*
Portland State University

Roberto Anitori
Clark College

Ernest Blackwell
Clackamas Community College

Andrea Blas
University of Guam

Jennifer Brock
University of Alaska Anchorage

Tracey Burke
University of Alaska Anchorage

Julia A. Burrows
Portland State University
Reed College

Alexis P. Cabrera
Northern Marianas College

Derek Helsham
American Samoa Community College

Lorna B. Liban
Northern Marianas College

Marilyn R. Mackiewicz
Portland State University
Oregon State University

Mika Maruyama
Clark College

Kathryn C.A. Milligan-Myhre
University of Alaska Anchorage

Perry J.C Pangelinan
University of Guam

Margaret Hattori-Uchima
University of Guam

Russell Reed
Chemeketa Community College

Benjamin E. Simon
Portland Community College

Beylul Solomon
Northern Marianas College

Alma M.O. Trinidad
Portland State University

Letisha R. Wyatt
Oregon Health & Science University

Alonso Delgado Covarrubia
Portland State University

Adrienne Zell
Oregon Health & Science University

Thomas E. Keller
Portland State University

Cynthia Morris
Oregon Health & Science University

Carlos J. Crespo
Portland State University

*Joint first author

Abstract: Research experience provides critical training for new biomedical research scientists. Students from underrepresented populations studying science, technology, engineering, and mathematics (STEM) are increasingly recruited into research pathways to diversify STEM fields. However, support structures outside of research settings designed to help these students navigate biomedical research pathways are not always available; nor are program support components outside the context of laboratory technical skills training and formal mentorship well understood. This study leveraged a multi-institutional research training program, Enhancing Cross-Disciplinary Infrastructure and Training at Oregon (EXITO), to explore how nine institutions designed a new curricular structure (Enrichment) to meet a common goal of enhancing undergraduate research training and student success.

EXITO undergraduates participated in a comprehensive, 3-year research training program with the Enrichment component offered across nine sites: three universities and six community colleges, highly diverse in size, demographics, and location. Sites' approaches to supporting students in the training program were studied over a 30-month period. All sites independently created their own nonformal curricular structures, implemented interprofessionally via facilitated peer groups. Site data describing design and implementation were thematically coded to identify essential programmatic components across sites, with student feedback used to triangulate findings. Enrichment offered students time to critically reflect on their interests, experiences, and identities in research; network with peers and professionals; and support negotiation of hidden and implicit curricula. Students reported the low-pressure setting and student-centered curriculum balanced the high demands associated with academics and research. Core curricular themes described Enrichment as fostering a sense of community among students, exposing students to career paths and skills, and supporting development of students' professional identities. The non-formal, interprofessional curricula enabled students to model diverse biomedical identities and pathways for each other while informing institutional structures to improve diverse undergraduate students' success in academia and research.

Keywords: professional development, sociocultural dynamics, cohort building, qualitative, training, emotional support, disparity, STEM, nonformal education, self-care, professional identity, diversity, equity, financial, socioeconomics.

Students from racial and ethnic minorities or low-income backgrounds as well as disabled students are underrepresented in health and science professions (Boekeloo, Jones, Bhagat, Siddiqui, & Wang, 2015; Duffus et al., 2014; Valantine & Collins, 2015), yet together these groups are becoming the majority of the U.S. population (U.S. Census Bureau, 2015). The National Institutes of Health (NIH) highlights that a more diverse group of students must be attracted to biomedical research careers, or the scientific workforce may not be fully prepared to address the increasingly complex nature of biomedical research (Scientific Management Review Board, 2015). Underrepresented minority (URM) scientists produce higher rates of scientific innovation, yet their careers are more likely to end prematurely (Hinton et al., 2020). Further, URM students are less likely to receive undergraduate and graduate degrees in science, technology, engineering, and math (STEM), including the fields of biological sciences, chemistry, and physics (Bonham et al., 2012; Hussar et al., 2020a; U.S. Department of Education, 2019). While many URM students enter undergraduate institutions with the express intent to pursue a STEM career, few emerge with STEM degrees (Hrabowski et al., 2011; Scientific Management Review Board, 2015). Potential root causes for this inequity include factors associated with low socioeconomic status and inconsistent access to relevant curricula (Scientific Management Review Board, 2015), as well as lack of mentorship, limited research internship opportunities (Cohen & Garcia, 2008), and lack of community due to being in environments that are not representative (Chang, Sharkness, Hurtado, & Newman, 2014; Clark Blickenstaff, 2005; Harrison & Tanner, 2018; Moss-Racusin et al., 2012). In 2010, URM individuals made up 29.3% of the U.S. population yet 8.3% of STEM doctoral degree recipients, and 7.3% of faculty positions (Estrada et al., 2016). In 2018, URM individuals made up 14% of doctoral degree recipients (National Center for Science and Engineering Statistics, 2018d) and ~26% of full-time faculty positions (Hussar et al., 2020b). Thus, while STEM and health disciplines are moving in the right direction, there is still a long way to go. Institutions and programs must continue to find ways to support, engage, network, and retain historically underrepresented students throughout their schooling.

To meet the need for training a diverse biomedical workforce, the NIH has funded 10 BUILD (Building University Infrastructure Leading to Diversity) sites nationwide to encourage and evaluate innovative approaches for undergraduate research training (Valantine & Collins, 2015; Valantine, Lund, & Gammie, 2016). The largest of the BUILD sites, EXITO, is a consortium of institutions representing five universities and six community colleges across the Pacific Rim. Richardson and colleagues (2017) described programmatic components of its intensive 3-year biomedical research training program, with its mentorship outlined by Keller and colleagues (Keller & Lindwall, 2020; Keller, Logan, Lindwall, & Beals, 2017). An important feature of the program is that many students start their training at partnering community colleges prior to transferring to the primary university. As 35% of the nation's 16.6 million undergraduates in 2018 were attending 2-year institutions, which typically enroll higher proportions of historically underrepresented students (Hussar et al., 2020a), this program's findings may inform the efforts of other institutions serving similarly diverse populations.

To enhance retention of historically URM students pursuing undergraduate biomedical research, the EXITO program recognized that URM students face systemic barriers and inequities whose negative effects require additional skills and resources to negotiate (Richardson et al., 2017), consistent with prior work by Ladson-Billings (1995). While STEM interest, motivation, self-efficacy, and identity may have brought these students to STEM fields and play an important role in their professional development (Boekeloo et al., 2015; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Jenson, Petri, Day, Truman, & Duffy, 2011; Maltese & Tai, 2011; Marriott et al., 2019; Usher & Parajes, 2008), additional factors contribute to STEM persistence. For example, both academic and scientific cultures can give mixed messages to URM students about their path to success. Harris and Gonzalez (2012; as cited in Trinidad, 2014) noted that "people of color and first-generation college students often face a contradictory culture of academia, and experience contentious places and processes" (Harris & Gonzalez, 2012). To support students, the EXITO program involves several hierarchical training components, including a multifaceted mentoring model (Keller & Lindwall, 2020; Keller et al., 2017), supervised research placements, and a Gateway to Research course. These interventions provide undergraduates access to research training by academic professionals with experience navigating academic and scientific cultures. However, cultural knowledge about best practices for supporting historically URM students may vary since few faculty have URM status themselves (Hussar et al., 2020b).

When considering interventions aimed at increasing URM students in STEM, Trinidad noted that academia itself "serves as a gatekeeper in accessing occupations, careers, and professions" (p. 17). For example, unique authority relationships are embedded in academic courses (professor–student), academic mentoring (faculty mentor–student mentee), and scientific research supervision (principal investigator–assistant). The authority figure controls critical factors for advancement such as grades, recommendations, and research access. Cultural norms in academia and research about what is wrong to say, do, and ask are unknown to students from families and communities where academic and research backgrounds are absent. Underrepresented students must also learn how to sustainably navigate academic and research cultures as well as represent themselves in the ways required of professionals in those areas, to enter and succeed in advanced degree programs in biomedical sciences.

Authors of this study are or were EXITO staff and faculty who provided support for undergraduate biomedical research trainees, including students from underrepresented backgrounds. We were involved in the development and implementation of a group support structure, termed Enrichment, at EXITO partner sites and engaged in reporting, analyzing, and/or summarizing the information presented in this case study. Predefined training models and procedures for students are typically documented, but support activities that emerge from direct work with students (around their needs) may leave no official data on what was done, how they were implemented, or why they were envisioned. As part of program development in the EXITO consortium, Enrichment activities had to be defined to allow consortium evaluation and to share best practices. The diversity of both students and sites in this consortium created an opportunity for a multisite case study to identify what activities, developed independently, support underrepresented undergraduate researchers. This article describes how Enrichment was designed and implemented, including how it evolved over 30 months to better meet student needs.

Materials and Methods

Setting

The EXITO program is overseen by Portland State University's Institutional Review Board (IRB). Primary data for this case study were collected from faculty and staff participating in the NIH-funded EXITO program who were involved in undergraduate training at partner sites. Portland State University (University 1) serves as the primary institution with 10 partner sites (Figure 1). Partner sites included Oregon Health & Science University (University 2; a research-intensive graduate institution), three Pacific Rim universities (University of Guam; University of Alaska-Anchorage; University of Hawai'i at Manoa; Universities 3–5), and six community colleges. Four community college partners were located in the Portland metropolitan area (Portland Community College, Clark College, Clackamas Community College, Chemeketa Community College) and the other two were located in the north and south Pacific (American Samoa Community College; Northern Marianas College). In 2018, the University of Hawai'i at Manoa and Chemeketa Community College stopped recruiting students and were not included in this study's follow-up data collection about Enrichment. In addition, Oregon Health & Science University is graduate-focused and was not included in this study, though serves as the research training site for some EXITO scholars at PSU. Secondary data were collected from undergraduate students participating in the NIH-funded EXITO program, with evaluations approved by the IRB.

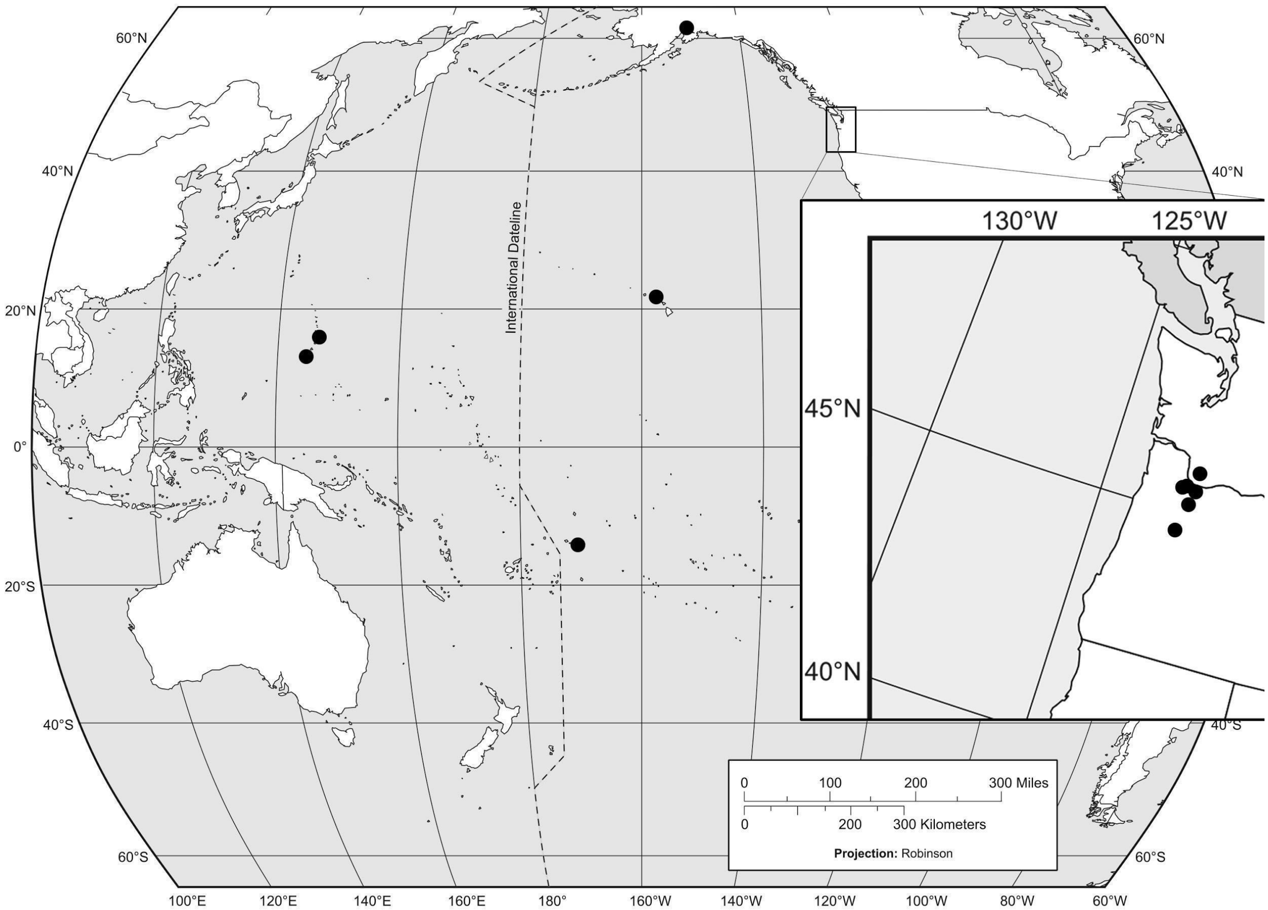

Figure 1. Location of EXITO sites representing 11 institutions (five universities and six community colleges). Data were collected from nine sites that had implemented Enrichment activities, with complete data from eight sites. Map adapted with permission from (Trapido-Lurie, 2010a, 2010b). *Note.* EXITO=Enhancing Cross-Disciplinary Infrastructure and Training at Oregon (EXITO)

Study Participants

Authors are or were faculty and staff serving undergraduates from diverse backgrounds pursuing biomedical research fields, including majors in biological sciences (e.g., biology, neuroscience, environmental health sciences), physical sciences (e.g., chemistry, engineering, physics), and social and health sciences (e.g., psychology, sociology, public health, social work, counseling, and education). Students aspired to research and/or practice careers in a range of biomedical disciplines and health professions (e.g., nursing, dentistry, medicine, pharmacy, physician assistant, radiation therapy, occupational therapy, mental health counseling, genetic counseling, etc.). At the primary university, EXITO biomedical majors had a 98% continuation rate and a 3.18 grade point average (compared to 82% and 2.94, respectively, for all biomedical majors at the primary university; institutional data from spring 2017). The program required 3 years of full-time enrollment, with community college students transferring to the primary university after the 1st year to engage in concurrent research internships for the last 2 years, with research intensives in both summers. Overall, EXITO retention was 82% (for biomedical students across all sites). For a national comparison, in fall 2017, the retention rate for all undergraduates across all majors, not limited to STEM, was 81% at universities and 62% at community colleges (McFarland et al., 2019a, McFarland et al., 2019b). For STEM majors alone, national retention rates have averaged 48% across all sites with the lowest retention rates (30%) at community colleges (Chen, 2013; Snyder & Cudney, 2017).

Demographics of EXITO program participants (Table 1) were obtained from students' program applications. URM students were defined using NIH definitions, including (a) racial/ethnic backgrounds of Black/African American, Native Hawaiian/Pacific Islander, Native American/Alaskan Native, and Hispanic and Latino/Latina/Latinx; (b) students with a disability; and (c) students with a disadvantaged background (NIH, 2019). Disadvantaged background was estimated from application data using two approaches: (a) scholar self-report (question independent of demographics) and (b) through the calculation of a composite variable that replicated NIH's 2019 definition of disadvantaged backgrounds for underrepresented populations (NIH, 2019). Criteria included (a) self-reported disadvantaged background, (b) first-generation college student; (c) eligibility for need-based financial aid (e.g., Pell grant); (d) foster care experience; or (e) previously or currently homeless. Fewer EXITO students self-reported their race as White (29%) compared to either the primary institution (67% in 2017) or 1st-year college students nationally (72% in 2016) attending public universities (Eagan et al., 2017). The EXITO evaluation team also provided scholar retention data across each of the 10 sites that enrolled scholars at any time.

Table 1. Demographics of students in the EXITO program.

Demographic category	*n* (%)
Gender (*N* = 427)	
Female	294 (69%)
Male	124 (29%)
Other/nonbinary/third gender	9 (2%)
Age (*N* = 406)[a]	
19 years or younger	212 (52%)
20–25 years	114 (28%)
26 years or older	80 (20%)
Race (*N* = 427)	
African American/Black	26 (6%)
Asian	73 (17%)
Native American or Alaskan Native	11 (3%)
Native Hawaiian or Pacific Islander	47 (11%)
More than one race	72 (17%)
White	125 (29%)
Other	53 (12%)
Unknown or not reported	20 (5%)
Ethnicity (*N* = 427)	
Hispanic or Latino/Latina/Latinx	99 (23%)
Not Hispanic or Latino/Latina/Latinx	247 (58%)
Other or decline to answer	81 (19%)
Other demographics	
Disability (*N* = 424)	48 (11%)
Disadvantaged background, self-report (*N* = 424)	225 (53%)
Disadvantaged background, composite score (*N* = 427)	369 (86%)
First generation college student (*N* = 426)	254 (60%)
Foster care experience (*N* = 427)	39 (9%)
Need-based financial aid (*N* = 427)	302 (71%)

Note. Cumulative demographics (Cohorts 1–5; application data). EXITO=Enhancing Cross-Disciplinary Infrastructure and Training at Oregon (EXITO)
[a] Age collected in program orientation surveys, with some missing responses.

Development of Enrichment at the Primary Site

The original EXITO training plan included these defined elements: an introduction to research course, research internship experiences, assigned faculty mentors throughout the program at all sites, assigned near-peer mentors at the primary site for students in their 1st year of the program, and dedicated advising for program students. Rather than attempting to predefine what key needs would be at each site, how they should be met, or how students would interact and respond, activities and support systems were allowed to evolve with the students and programs at each site. Recognizing the benefit of student support (Appendix A), EXITO leadership defined Enrichment as an official program intervention in Year 2, with all sites needing some type of student enrichment, though its form, content, and definition was left up to each site. Activities at the primary site occurred on a regular schedule of required sessions (Appendix A). Student evaluation of Enrichment at the primary site began in Year 3.

EXITO Conference and Baseline Data Collection

An annual EXITO conference brought teams from each site together in person to plan curricular and programmatic components. This collaborative, nonhierarchical approach defined a set of consortium-wide shared learning objectives for all Gateway to Research courses in the early years of the BUILD EXITO grant and its annual conference, despite courses being created by faculty in different fields and taught in different formats at diverse institutions. By 2018 (Year 3), program leadership supported using this collaborative approach to define and assess other program areas, including Enrichment, a focus area for the summer 2018 conference. Enrichment offered an opportunity for sites, and for the program as a whole, to identify any common features (i.e., structure, content) in what their institutions had created to support the success of underrepresented undergraduate researchers pursuing biomedical research.

To understand how Enrichment was designed and implemented at partner sites, the Enrichment coordinator emailed instructional leads at each institution in April 2018. A five-question digital survey included one question each about instruction, format, and goals plus two questions about learning objectives (Appendix B). All partner sites were emailed except the research partner (OHSU), as it provided research placements only. To support data collection, the Enrichment coordinator met with instructional leads or teams from all local-area partners. All sites reported the same barrier to returning data: They had not created an Enrichment program. However, when asked to describe what they did with their EXITO students outside of the required course and mentor meetings, every site immediately described specific organized and intentional group activities for EXITO students, often held on a regular schedule. When asked why they had not reported these activities as their Enrichment, all sites independently gave one or both of the following responses. First, they had not believed that informal activities could be formally documented or that a research training program would be interested in documenting informal activities. Second, they did not think that activities that were not direct research skills training could "count" as supporting student research training. One faculty member from an underrepresented background in academia and research who was experienced with URM students in STEM summed up many comments we received across sites: "This is just what we do. Because our students need it. We know they need it because we've been there ourselves." Following in-person meetings, each local site quickly returned baseline data.

Following these conversations, the Enrichment coordinator emailed nonlocal sites to clarify that Enrichment could include any type of activity and did not have to be predefined as a formal intervention. All sites except University 5 returned information.

At the June 2018 EXITO conference, results of the baseline data collection on Enrichment were shared. The survey had asked about learning objectives, given the consortium's previous success in defining shared learning objectives for diverse EXITO Gateway to Research courses. However, the consortium concluded that Enrichment did not have shared instructional learning objectives. Instead, Enrichment shared a curricular structure across sites: nonformal education using facilitated instruction with peer and near-peer group activities. The consortium defined a preliminary list of Enrichment focus areas based on the activities at the sites, which sites could use to define and focus their content goals for Enrichment.

Follow-Up Data Collection

To understand how Enrichment was implemented across sites, a follow-up survey was emailed to active Enrichment leads in November 2019 (18 months later). The survey included the same prompts from the baseline survey along with three additional prompts (Appendix B): "What have you learned about offering enrichment to your students? What feedback have you received from students about enrichment thus far (course evaluations, word of mouth, anecdotes, etc.)? Anything else you want us to know?" All sites returned documentation within 2 weeks without in-person meeting support.

Qualitative Data Analysis

Text from baseline and follow-up surveys were uploaded to Dedoose (version 8.1.8; Los Angeles, CA) for thematic content analysis (Green & Thorogood, 2014). A faculty member who teaches graduate-level qualitative methods completed the coding, with a review of code definitions and themes for face validity by the EXITO lead evaluator and Enrichment program coordinator. To protect site privacy, data from the nine participating institutions were coded using the following designations: primary university (i.e., University 1), university (i.e., Universities 3 and 4); urban community college (i.e., Community Colleges 1–3 and 6), or distant community college (i.e., Community Colleges 4 and 5, both located over 5,000 miles from the primary university). Code applications for each site type were compiled in a data matrix within Dedoose and exported to Excel for secondary analysis of themes. The number of sites that reported each theme as well as the average number of mentions of that theme by site type were computed.

Student Evaluation Data Collection

While Enrichment programmatic features were coded from instructor and team perspectives, student perspectives were collected using informal "course evaluations" implemented at the primary site at the end of students' final term of Enrichment (Appendix B). Because all students from partnering community colleges finished the program at the primary institution, this Enrichment data included students from seven of the nine participating partner sites. The evaluation asked about overall feelings about Enrichment, thoughts on it being mandatory, key gains/gaps, and instructor ratings. Survey administration occurred at the end of winter term (last term of EXITO) in both 2019 and 2020, with each senior cohort comprising over 55 students. Questions were identical across surveys with two items added in 2020: (1) institution where the scholar started EXITO (checkbox option of primary university or transfer institution; and (2) "Enrichment connected me with my peers"(Appendix C). A 6-point Likert scale captured overall feelings about Enrichment, with responses scored from 1 (*strongly* *disagree*) to 6 (*strongly agree*). Scholars' percentage agreement was computed from those who answered 4 (*slightly agree*), 5 (*agree*), or 6. Data was compiled in Excel before transfer to SPSS (IBM, version 26) for statistical analyses.

Member Checking

A final survey was sent to all prior Enrichment leads in October 2020 (about 30 months after baseline data collection), which presented summarized themes from the qualitative analysis (Table 2) and asked each lead to rate the frequency and impact of these themes at their site on a 0–100 scale (prompts in Appendix B). Frequency data that were left blank were recoded as 0. Impact data were not recoded.

Statistical Analyses

Statistical analyses compared whether student responses differed between years and whether transfer status influenced ratings. "Course evaluation" data were descriptively analyzed within SPSS for means and standard errors, reported in graphical displays. Data were tested for normality using the Shapiro–Wilk test of normality and Levene's test for homogeneity of variance within SPSS, with significance values above .05 describing normally distributed data. Nonparametric independent samples t tests (Mann–Whitney U test) were used to analyze Likert-scale data for statistical differences (Norman, 2010), including student data between survey years (i.e., 2019 vs. 2020) and starting institution (e.g., primary university vs. transfer institution) as well as instructor data (frequency and impact for university vs. community college sites).

Results

Qualitative Analysis of Themes

Sites described Enrichment across the following core areas: goals and core responsibilities; learning objectives; structure and format; measurement and outcomes; barriers; implementation solutions; and key changes over the 30-month study period. Data definitions and example quotes for all coded themes are described in Appendix D.

Goals and core responsibilities. Sites were asked to describe the thematic goals of Enrichment as separate prompts ("goals" and "core responsibilities"), though responses were interchangeable and merged to facilitate reporting of themes. Twelve goals and core responsibilities emerged (see Table 2). Subthemes are described in Appendix E, with the prevalence of each theme across site type shown in Table 3. In October 2020, sites were presented with the summarized list of themes and asked to rate each theme's frequency of inclusion and perceived impact on scholars at their site (Table 4), thereby highlighting core elements needed across university and community college environments to support URM students in biomedical research training programs.

Table 2. Themes observed for the Enrichment program's goals and core responsibilities.

Code	Definition	Example quote
Research exposure	Students learn about different fields of research and topic areas within research	"Ensure students have exposure to areas of science that align with their short-term and long-term educational and career goals." — urban community college
Path representation & networking	Students meet professionals in their desired area of interest and learn what it takes to pursue a particular career path. Students can network and talk with professionals who may have been previously unknown to them	"Increase the breadth of students' experience of who does science, what science looks like, and the range of scientific work." — urban community college
Research skills	Students develop specific research skills (e.g., learning statistics, writing an abstract, understanding research ethics, conducting a literature search, etc.) Also includes exposure to and practice with basic activities done in research (e.g., fundamental bench laboratory techniques)	"Critical thinking and problem-solving development, intellectual development, shows understanding of ethical conduct, demonstrates advanced level of content knowledge skills and methodologies, and applies feedback from mentor effectively." — partner university
Build professional identity	Students talk about becoming a professional/researcher in their field of interest, what it looks like, what gaps may exist. This code also includes portfolio development, which creates and reflects the existence of a professional self	"Supporting development of research identity and self-efficacy (I can do science, scientists are real people, I have the same chance as anyone else to be a scientist)" — urban community college
Knowledge & building self-efficacy	Students learn about research components (could be path specific or path agnostic); helps build the competence to apply that knowledge	"Increase student self-efficacy (through practice of activities and communication related to EXITO core themes: awareness-building, responsibility, sustainability, ethics)" — urban community college
Research relevance	Describes making research more personal and relevant for students, typically by considering uses for specific populations in their own community, community service to understand needs in others, or other components that build relevance	"Homeless Outreach — To expose students to this vulnerable population which also suffers from health and socioeconomic disparities. Students also gain an increased awareness of issues surrounding homelessness on [island], and services available to assist homeless individuals and families. — partner university
Sociocultural dynamics	Describes talking about dynamics that affect marginalized populations in academic and research environments (such as first-generation college students, Black people, women in "hard science," people with disabilities). Often includes strategies for responding to microaggressions, cultural bias, systemic racism	"Provide clear understanding of common expectations, and common issues or pitfalls that underserved and underrepresented students may experience on the educational and career path of their choice." — urban community college
Professional development	Describes skills, growth, and access that support the ability to add research responsibilities to academic and personal responsibilities	"As students become scholars, we discovered that there was a great demand for students to learn other hidden skills such as effective note taking, study habits, and skills for long-term

	(may include time management skills, resources, self-reflection, i.e., what do I need to function as a professional?)	retention of information through retrieval practice. There was also a demand for developing etiquette for professional environments such as conferences and meetings."— primary university
Self-care	Similar to professional development, but focused more on mental health, social and emotional pressures related to work–life balance, and strategies that mitigate burnout in professional settings (i.e., what are the advanced skills required for me to flourish in a professional life, particularly in research and academia?)	"Life skills for underserved and underrepresented professionals (work–life balance; accessing support; managing high biosocial demands and stresses with high academic and professional expectations)" — urban community college
Cohort & team building	Provides opportunities for students to get to know each other, share stories/issues/concerns, and help each other in their path development	"Cross-cohort interaction is very helpful: peer mentoring, normalizing interest in science, information-sharing on transfer preparation and academic success." — urban community college
Support	Describes helping students navigate supports available at institutions as well as responding to emergent needs. Also includes description of mentorship when it is described as a support for students.	"Regular in-person contact with Scholars: to listen and notice student needs, support access to resources, help identify the need. The student won't go to an advisor or student services until they recognize the need." — urban community college
Institutional infrastructure	Describes institutions learning from students to improve instruction or discover student needs and create or improve resources/access. Often describes how sites institutionalized courses or student supports	"Give local EXITO core faculty a chance to "take the pulse" of students on a regular basis, identify red-flag issues before they become problems" — partner university

Table 3. Enrichment goals and core responsibilities reported across sites, sorted by prevalence described across sites.

Prevalence	Core theme	Total sites *n* (%) describing theme; mentions/site	Primary university *n* (%) describing theme; mentions/site	Partner universities *n* (%) describing theme; mentions/site	University subtotal *n* (%) describing theme; mentions/site	Urban community colleges *n* (%) describing theme; mentions/site	Distant community colleges *n* (%) describing theme; mentions/site	Community college subtotal *n* (%) describing theme; mentions/site
1	Cohort/team building	9 (100%); 2.2	1 (100%); 32.0	2 (100%); 9.0	3 (100%); 13.7	4 (100%); 3.5	2 (100%); 1.0	6 (100%); 2.3
2	Professional identity	8 (89%); 12.5	1 (100%); 59.0	2 (100%); 5.0	3 (100%); 23.0	4 (100%); 6.5	1 (50%); 5.0	5 (83%); 6.2
3	Research skills	8 (89%); 11.4	1 (100%); 37.0	2 (100%); 13.5	3 (100%); 21.3	3 (75%); 3.0	2 (100%); 9.0	5 (83%); 5.4
4	Path representation/networking	8 (89%); 10.4	1 (100%); 44.0	2 (100%); 4.5	3 (100%); 17.7	4 (100%); 6.5	1 (50%); 4.0	5 (83%); 6.0
5	Professional development	8 (89%); 5.4	1 (100%); 19.0	1 (50%); 3.0	2 (67%); 11.0	4 (100%); 3.5	2 (100%); 3.5	6 (100%); 3.5
6	Research relevance	7 (78%); 5.4	1 (100%); 3.0	1 (50%); 9.0	2 (67%); 6.0	3 (75%); 3.0	2 (100%); 3.5	5 (83%); 3.5
7	Research exposure	7 (78%); 4.1	0 (0%); 0	2 (100%); 4.0	2 (67%); 4.0	3 (75%); 5.7	2 (100%); 2.0	5 (83%); 4.2
8	Institutional infrastructure	7 (78%); 3.3	1 (100%); 6.0	2 (100%); 3.0	3 (100%); 4.0	3 (75%); 3.0	1 (50%); 2.0	4 (67%); 2.8
9	Sociocultural dynamics	6 (67%); 6.7	1 (100%); 20.0	1 (50%); 3.0	2 (67%); 11.5	4 (100%); 4.3	0 (0%); 0	4 (67%); 4.3
10	Support	6 (67%); 5.7	1 (100%); 19.0	0 (0%); 0	1 (33%); 19.0	3 (75%); 4.0	2 (100%); 1.5	5 (83%); 3.0
11	Knowledge/self-efficacy	6 (67%); 2.2	1 (100%); 3.0	1 (50%); 1.0	2 (67%); 2.0	3 (75%); 2.3	1 (50%); 2.0	4 (67%); 2.3
12	Self-care	5 (56%); 2.2	1 (100%); 3.0	1 (50%); 1.0	2 (67%); 2.0	2 (50%); 3.0	1 (50%); 1.0	3 (50%); 2.3

Note. Instructors at each site were asked, "What are your goals [and] core responsibilities?" The number and percentage of each institution type mentioning that theme were calculated as frequency of sites mentioning a theme divided by total sites in that institutional setting. Data included one primary university, two partner universities, four urban community colleges, and two distant community colleges, for a total of nine sites. Mentions/site were calculated by dividing the number of mentions of the theme by the sites describing that theme. Of note, the primary university data reflect an increased number of instructors and mentions compared to other sites, because the primary university had three sections of students (sophomores, juniors, seniors) with separate leads, coded together to represent the site's approach to enrichment.

Table 4. Post hoc perception of Enrichment themes across sites, ranked by overall average (frequency covered and perceived impact on students).

Theme	Frequency of coverage (*M*; *SD*; *n*)				Perceived impact on students (*M*; *SD*; *n*)				Overall average rank
	University	Community college	Overall	Rank	University	Community college	Overall	Rank	
Cohort & team building	87.3, 14.7, 8	73.8, 22.3, 6	81.5, 18.8, 14	1	87.6, 12.1, 8	84.2, 11.1, 6	86.1, 11.4, 14	1	1.0
Professional development	86.3, 16.9, 8	23.5, 26.6, 6	59.4, 38.3, 14; ***	3	91, 10.3, 8	40, 26.5, 3	77.1, 27.9, 11; *	4	3.5
Self-care	79.4, 25.6, 8	28.7, 31.2, 6	57.6, 37.5, 14; *	6	84.4, 30.9, 8	67.8, 33.3, 4	78.8, 31.2, 12	2	4.0
Build professional identity	86.5, 18.6, 8	21.7, 40.2, 6	58.7, 43.8, 14; *	5	80.8, 23.5, 8	65, 49.5, 2	77.6, 27.3, 10	3	4.0
Support	81, 13, 8	60, 39.5, 6	72, 28.4, 14	2	69.4, 21.8, 8	76, 26.7, 6	72.2, 23.2, 14	6	4.0
Research exposure	70.5, 41, 8	43.3, 38.3, 6	58.9, 40.8, 14	4	74.4, 18.3, 7	58, 32.7, 5	67.6, 25.4, 12	9	6.5
Sociocultural dynamics	78.5, 25.7, 8	8.3, 13.3, 6	48.4, 41.5, 14; ***	9	84.1, 31.4, 8	91, 10.3, 1	77, 36.3, 9	5	7.0
Path representation & networking	79.5, 21.1, 8	18.3, 19.4, 6	53.3, 37, 14; ***	8	85.3, 19.7, 8	32.5, 29.9, 4	67.7, 34.1, 12; *	8	8.0
Knowledge & building self-efficacy	70.3, 33, 8	40, 43.4, 6	57.3, 39.4, 14	7	67, 32.7, 8	67.5, 34, 4	67.2, 31.6, 12	10	8.5
Research relevance	55.4, 31.7, 8	31.7, 41.2, 6	45.2, 36.6, 14	11	76.6, 21.4, 7	55, 63.6, 2	71.8, 30.7, 9	7	9.0
Research skills	52.6, 41.5, 8	36.7, 22.5, 6	45.8, 34.5, 14	10	65.9, 32.2, 7	49.2, 29, 5	58.9, 30.7, 12	11	10.5
Institutional infrastructure	52.9, 29.3, 8	26.7, 41.8, 6	41.6, 36.3, 14	12	56, 25.7, 8	50, 70.7, 2	54.8, 32.8, 10	12	12.0

Note. Instructors at each site were asked to rate each theme by frequency of coverage (0 = not at all; 100 = core component discussed frequently) and its impact on scholars at their site (0 = no impact; 100 = maximal impact). Statistical differences in means were analyzed by nonparametric independent samples *t* tests.
$^*p < .05$. $^{***}p < .001$.

Learning objectives. The stated learning objectives for Enrichment at each site were coded according to Bloom's taxonomy of cognitive learning objectives (Adams, 2015) describing six ascending levels of cognitive order (1–6). Table 5 indicates these different levels, the proportion of learning objectives at each level, and a summary description of the types of learning objectives represented at each level (Table 5). Appendix F further describes thematic analysis of learning objectives as well as context, barriers, solutions and key changes.

Table 5. Bloom's taxonomy of cognitive learning objectives applied to Enrichment learning objectives across sites.

Bloom's level	Proportion of responses	Description
1. Knowledge *(recall)*	10%	Describes the learning and repetition of information, such as identifying research methodologies or resources.
2. Comprehension *(explanation)*	26%	Centered on students talking with peers and professionals, since these activities emphasized understanding and explaining points of view that may be different from their own.
3. Application *(information use)*	32%	Describes students applying knowledge and using information to access student support services, apply rational decision making to their research, and implement ways to handle the demanding expectations of their educational and career plans.
4. Analysis *(connection)*	21%	Most often referred to evaluating scientific sources, making comparisons across scientific fields of study, and self-identifying gaps in professional preparation.
5. Evaluation *(justification)*	12%	Described using scientific information to make conclusions and describe limitations within research, as well as the evaluation and articulation of advantages and disadvantages of research careers so students could justify whether a path would be right for them.
6. Creation *(production)*	14%	Referred to development of professional materials, such as personal statements, professional portfolios, oral conference presentations, visual poster presentations, and other materials that showcased students' development and identity as professionals and researchers.

Structure and format. This core area referred to logistics and common practices for running an Enrichment program. Enrichment generally consisted of 60- to 90-minute sessions offered weekly or biweekly, although some sites held them less frequently (e.g., 1–2 times/term). Depending on the size and capacity of the site, Enrichment was facilitated by one or more faculty and/or academic professionals. A thematic analysis of program components is summarized in Appendix F, including instruction, frequency and duration, audience and attendance, approach to content, activities, instructional supports, and online resources.

Measurement and outcomes. Sites reported measurement outcomes and measurement opportunities, as well as areas where they would feel strong or weak in evaluating learning objectives (Appendix F). Few sites implemented "course" evaluations, though several cited a desire to work with the program's evaluation team to design and implement Enrichment evaluation with their students.

Subthemes around professional development and student engagement were cited as measurement outcomes of interest. In 30-month follow-up surveys, evaluation had increased at one distant community college site (e.g., positive impact of research symposia and students describing "how...the peer mentoring they receive and support from their cohort and previous cohorts have had such a great impact on their success in the program"). Another urban community college site reported an easy metric for estimating cohort engagement:

> One of my hallmarks of whether a cohort has been established is when students begin to ask how other students are doing or where they are at if they miss a class or meeting. That indicator that they are looking out for and supporting each other is why I ranked the cohort and team-building component relatively high for our students.

Barriers. Barriers refer to implementation challenges (e.g., travel logistics, limited access to scientists at distant sites, busy student schedules) as well as larger systemic barriers that intersect to impact students' progression in biomedical research training programs (Appendix F). For example, 71% of the program's students are on need-based financial aid. An urban community college partner cited the NIH requirement that students must be continuously enrolled with full-time credits to participate in the program. However, since students are unable to reduce their course load without losing all their program funding for that term, extra support is required to keep students enrolled full time through a crisis (e.g., illness, death in family) or relocation to a new institution.

Implementation solutions. Implementation solutions describe strategic considerations and effective solutions for designing and delivering Enrichment's nonformal, interprofessional structure (Table 6). These include approaches to both delivering content (e.g., mentored support, peer sharing, core logistics) and expanding delivery or reach (e.g., institutionalization and partnerships; sharing across sites). Enrichment served as a way to identify student needs as well as refer students to resources, when needed (Appendix F). Appendix G describes additional lessons learned for implementing Enrichment with biomedical research trainees.

Key changes over the study period. Baseline and follow-up data were coded to understand significant changes that sites made to Enrichment over the 30-month study period. Key changes included a greater emphasis on professional development, implicit curricula about social norms and dynamics of academic and research cultures, and self-care in science (Appendix F). Over the 30-month follow-up, instructional teams became more diverse, including not only staff and faculty, but postdoctoral fellows and program alumni who returned as hired staff to serve as peer mentors and develop scholar-facing content (e.g., web content, management of Slack/Discord channels, and topic tutorials) for the Enrichment program. A community college site also recommended effective resources for their students, such as the *At the Bench* book on laboratory practices (Barker, 1998), which they reported "helped [students] feel more competent and confident entering the research setting" and "reduced feeling[s] of imposter syndrome." Team-building (with peers, peer-mentors, faculty, and staff) was essential; sites' reported that it helped scholars' build academic self-efficacy and confidence, constructs that can be measured among students as a future direction of this work.

Effective curricular arcs for biomedical enrichment. Summarized themes for 3-year instructional arcs were successfully implemented at the primary university over the 30-month study period (Table 7). Core arcs describe areas of work such as developing identity, finding fit, communicating identity as a professional, and gaining access to advanced academic and professional systems. When examined with Table 4, institutions should integrate peer discussion (cohort/team-building) as a best practice when discussing these themes.

Table 6. Enrichment implementation solutions across sites.

Solution	Proportion of responses	Description
Mentored support of professional development	40%	Described the value of providing support to students to help them navigate their professional paths, identify training gaps, understand cultures, and integrate new skills (e.g., time management by online scheduling) into their larger identities. Student support and success solutions consistently included peers, program alumni, and diverse professionals in flexible mentoring processes. Several sites described offering support to students for professional writing.
Peer sharing and student-led content	35%	Described the high value of including peer sharing and student feedback in the development of content and goals for Enrichment. Given students' busy schedules, supporting their autonomy in how they meet their needs is key. Sites described that as scholars became networked with each other, they learned to support and rely on each other in times of strength, weakness, success, and failure.
Logistical supports	30%	These included consistent day, time, and meeting locations to improve attendance, as well as the use of course management software to help share announcements and resources with students. Sites described integrating evaluation into their processes, particularly for new events, as important logistics to consider to ensure activities are working for students.
Institutionalization and partnerships	25%	Referred to processes for institutionalizing Enrichment with or without additional research instruction (i.e., a Gateway to Research course that teaches research ethics and methodology). As sites recognized the importance of a peer base for Enrichment, they became creative in how to increase the number of students accessing Enrichment. Two sites hoped to offer Enrichment as a noncredit course to recruit students beyond the program, and others implemented formal and informal partnerships with other STEM programs that supported undergraduate research (e.g., NASA URISE) to implement Enrichment across a wider student population. This strategy likely benefits both institutions and students since Enrichment excels as an interprofessional environment. However, as Enrichment becomes institutionalized, one urban community college said it best: "While institutionalization of the [site's] Gateway class has been our goal for a number of years, now that it appears to be coming to fruition we need to ensure that the move from "unofficial" to official class with greater numbers of students won't lead to a loss of informality. It is this atmosphere that has encouraged and allowed open and honest discussions. It would be a shame to lose this environment that enriches all participants, not just the scholars."
Sharing across sites	14%	Referred to sites' desire to share resources, instructional materials, and lessons learned with greater intent and frequency. Structures to share resources and activities online was encouraged, as was establishing instructional development around Enrichment as a regular part of the annual EXITO conference.

Note. STEM=Science, Technology, Engineering, and Mathematics; NASA=National Aeronautics and Space Administration; URISE=Undergraduate Research Internship in Science & Engineering); EXITO=Enhancing Cross-Disciplinary Infrastructure and Training at Oregon (EXITO)

Table 7. Effective curricular arcs and goals for Enrichment across a 3-year training program.

Area of work	Core questions	Program Year 1 (Sophomore)	Program Year 2 (Junior)	Program Year 3 (Senior)
Developing identity	--Who am I? --What am I good at? --What do I want to do?	Strengths assessment; cohort-building activities; exposure to academic and scientific fields	Identifying field(s) of interest; identifying academic/research interests; identifying a good program/mentor fit	Networking, interview, and presentation practice; creating a professional identity online and in person (e.g., individual development plan, e-portfolio);
Finding fit (integrating identity and role)	--What are the roles and groups within academia? In research? --What role(s) do I have? What group(s) am I part of? --What roles in academia and research are a good fit for me? --What groups (sociocultural, professional, academic) are a good fit for me?	Exposure to diverse academic and scientific professionals and communities; cultures of science across natural, social, and clinical fields; understanding systemic barriers and imposter syndrome; degree/job paths across natural, social, clinical, and professional fields; roles in research teams	Small-group talks; deepening exposure to diverse professionals and communities; identifying academic pathway(s) of interest; building network using professional associations and conferences; cultures of research (e.g., academia, industry, government settings); negotiating strategic self-disclosure as an underrepresented professional	Negotiating underrepresentation; transition strategies for the following year (gap year, postbaccalaureate programs, work-to-graduate-school paths); completion of remaining steps (e.g., GRE, MCAT, interviews); defining a personal timeline and needs in a job or program; demythologizing the "straight track" to a terminal degree
Communicating identity as a professional	--How do I represent my identity to others as a professional? --How do I recognize and describe, in a professional way, roles and groups that fit me well?	Developing documents used for research placement (e.g., resume, short interest statement); networking using student groups; professional tools and skills (e.g., business cards, presentation practice, negotiation skills)	Building an application portfolio (for postbaccalaureate, graduate school, professional programs, internships, jobs), including personal statement, curriculum vita, cover letter, statement of research interests, asking for letters of recommendation	Revising the portfolio, with poster(s), publication(s), conference experience, updated curriculum vita and recommenders; creation of professional digital identity; networking and planning skills
Gaining access	--What do I need to do to join/create these groups and communities? What is my next step? --What do I need to do to gain access to/qualify for these roles? What is my next step?	Building relationships with career and research mentors; research laboratory placement; networking with peers, faculty, and peer mentors	Graduate school, professional program, postbaccalaureate, internship, and job list; informational interviewing; funding sources for advanced schooling	Professional association membership(s); "offboarding" plan describing graduate program choice or gap plan with funding goals, target employers, or postbaccalaureate application; transition to paid support role in the path of interest

Student Evaluation of Enrichment

To understand student perceptions of Enrichment, students at the primary university were given "course" evaluations at the end of the academic year. Data were collected from students at all community colleges and the primary institution, but not from partner universities. A total of 57 seniors completed Enrichment course evaluations (Figure 2), representing 33 Cohort-2 scholars (of 57 in March 2019, 58% response rate) and 24 Cohort-3 scholars (of 56; in March 2020, 43% response rate). The response rate averaged 50%, representing 13% of EXITO's total student population (N = 427; Table 1). Scholars agreed with most statements about Enrichment (Figure 2; percentage agreement calculated from Likert scale ratings >3), including that it made them feel supported (98% agreement), had a large impact on [their] professional development (95%), and helped [them] understand career path options (91%). Responses were similar across the 2 years ($p \geq .05$), with higher scores observed in 2020 for organization (4.6 to 5.2; $p < .01$) and resources/materials (4.6 to 5.0 $p < .03$). Cohort-3 course evaluations asked scholars if they started EXITO at the primary institution or transferred, with no statistical differences in any ratings based on scholars' starting institution ($p > .07$–1.0). Scholars grew in their appreciation of Enrichment being mandatory by 1 point, from 5.6 ± 0.3 at the start of Enrichment to 6.6 ± 0.3 at the end (1 = *strongly dislike*; 10 = *strongly like*). Senior scholars were asked if they would attend if Enrichment was not mandatory, with 33.3% indicating yes, 45.6% indicating their attendance was dependent on the session topic, 14% reporting no, and 7% unsure. At the 30-month check-in, the primary institution had implemented additional engagement options to accommodate students with busy schedules and diverse needs, including online cross-cohort sessions, supplemental enrichment, and weekly writing workshops offered virtually to support students across sites.

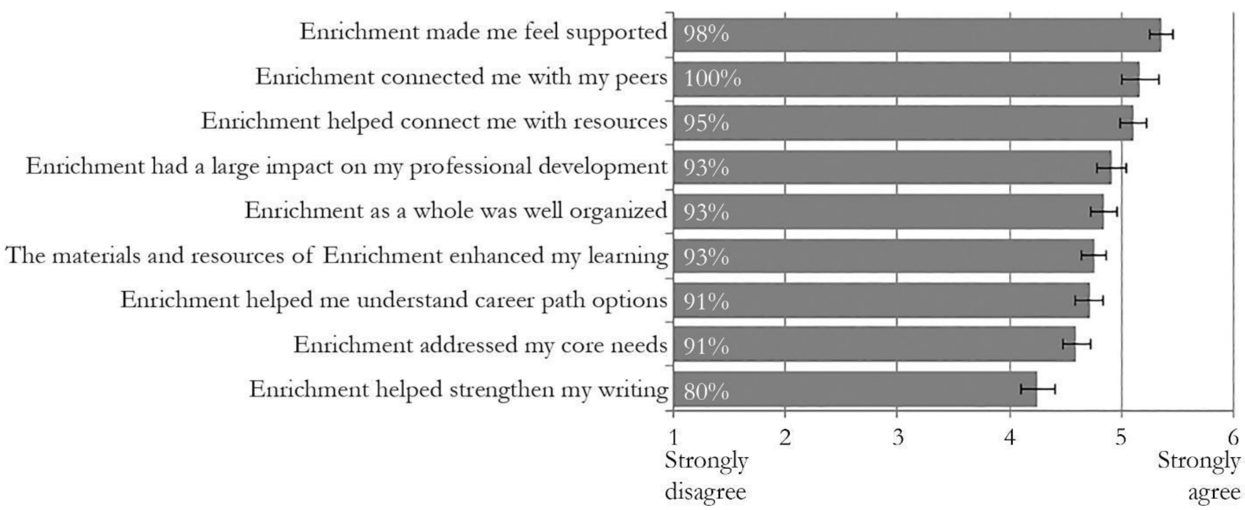

Figure 2. "Course evaluation" data from seniors completing EXITO at the primary university. A total of 57 seniors completed course evaluations and rated Enrichment on a Likert scale of 1 (*strongly disagree*) to 6 (*strongly agree*). Mean and standard error are shown, with scholar percentage agreement (rating >3) inset. Items denote 57 responses except for "career path" and "writing" questions (n = 56) and "connecting with peers" (n = 24; asked of Cohort 3 only).

Discussion

Enrichment served as an important nonformal support structure for historically underrepresented undergraduates pursuing biomedical research training. Enrichment is defined as a learning structure that enabled students to have regular connection with peers, faculty, and staff over time for the specific purpose of addressing the needs of students navigating academic and biomedical research training paths. Understanding what supports are needed to retain historically URM students in research training is critical to enhance representation in the biomedical workforce (Duffus et al., 2014; Estrada et al., 2016; Hinton et al., 2020; Valantine & Collins, 2015; Valantine et al., 2016). The nonformal, interprofessional structure differs from other academic and training environments and fulfills a needed role. For example, while course instruction enables group contact with students about a topic, it is limited in time (i.e., term) and predefined by instructional learning objectives. Mentoring provides regular contact over time and is driven by student needs, but each mentor sees a limited subset of students; patterns that affect a larger group or minorities within a group may be invisible to both mentor and mentee. Advising offers an individual lens; the advisor sees the pattern of needs in many students over time, but interactions are typically 1:1 without peer interactions or group feedback to advisors. The Enrichment role was unique. This study of Enrichment implementation represents a multisite case study of how regular group interaction over time with an interprofessional population of historically URM students can inform faculty and staff understanding of the diverse population's needs, and the kinds of program or institutional activities that can address them. While URM refers to students from historically underrepresented racial and ethnic minority groups, the term is also inclusive of students with disability and disadvantaged backgrounds, including those in the foster care system and from low socioeconomic backgrounds. EXITO serves a diverse population of students, including historically URM students, gender and sexual minority students, and Asian/Pacific Islanders who grew up in socioeconomically-disadvantaged environments in American Samoa, Guam, Hawai'i, or Northern Mariana Islands.

Enrichment instructional team members had very diverse job roles in higher education, came from different demographic backgrounds, had attained degrees in diverse STEM and non-STEM fields, and had no common training beyond research ethics (Appendix F). Based on their regular group contact with diverse underrepresented undergraduates pursuing biomedical research training, all sites independently developed Enrichment with the same features: peer- and near-peer-based facilitated interprofessional learning, with access to diverse professionals in contexts where they did not have direct authority over the student's grades or work, using nonformal education structures.

Enrichment's ability to meet needs across nine diverse institutions (three universities and six community colleges across the Pacific Rim) suggests high potential generalizability and applicability to other sites nationwide. In nonformal structures, instruction responds to learners in situations rather than adhering to predefined instructional objectives (Melnic & Botez, 2014; Yasunaga, 2014), with students' voices and available opportunities used to develop instructional goals. The Enrichment process was highly valued by students, as 98% reported in course evaluations that they felt supported and 91% agreed that Enrichment helped them understand career path options. Enrichment provided facilitated time for students to explore biomedical paths, visualize themselves as scientists, understand systemic barriers, add academic and research languages and cultures to their tool kits, and find ways to access further education and research that fit their life situations, interests, values, and goals. Supporting students' informed choices and autonomy about their career decisions is vital for students who face barriers to biomedical research careers, such as URM students (Chang et al., 2014; Hrabowski et al., 2011; National Science Foundation [NSF], 2017), particularly since advanced training in these fields may take a decade or more.

Interprofessional Setting of Enrichment Mirrors Biomedical Research

All sites reported that the interprofessional setting of Enrichment, an important feature of biomedical programs given their diversity of majors and degree paths, was also important for student development. Interprofessional education refers to students from different disciplines learning with, from, and about each other (Health Professions Accreditors Collaborative, 2019) and has become an increasingly common component of scientific training programs (Averill et al., 2019; Health

Professions Accreditors Collaborative, 2019). Enrichment's interprofessional setting supported student-led modeling and exploration of different professional degrees (e.g., M.D., R.N., M.S.E., Pharm.D.), research paths (Ph.D., M.D./Ph.D., M.S.), and career options after graduation. As diverse students explored these paths together, they self-defined paths, programs, and timelines that would allow them to successfully pursue their goals given their situation and interests. The interprofessional setting enabled students across the physical, biological, clinical, and social sciences to share similar experiences and feelings about professional identity development, which helped others realize they were not alone when questioning how they could become a scientist and what it means to be one. Identifying common experience was key for underrepresented professionals to distinguish personal barriers from systemic barriers and identify when solutions needed more individual effort or better access to systems. Enrichment provided a space and time in which URM individuals were the visible majority and could serve as role models, informal mentors, and search images for "scientists like me." The inclusion of program alumni in Enrichment was particularly meaningful, as these students could share proven strategies for negotiating underrepresentation and balancing research, academics, and personal life. While formal faculty mentor meetings have their own unique value, our study data show that student support and success solutions identified across sites consistently included peers, program alumni, and professionals from a variety of backgrounds, including underrepresented populations.

Enrichment Provides the Reflection Time for Students to Develop Their Professional Identity

While a desire exists among grantors and training programs to help students find career paths and access graduate programs as quickly as possible, underrepresented students may need more time to observe and evaluate the academic and research landscapes. Most program students (71%) received need-based financial aid, 86% reported a disadvantaged background, and 60% were first-generation college students. Graduate fields and degree programs differ in their financial support for students (National Center for Science and Engineering Statistics, 2018b, 2018c) and students' path selection can influence accrued student debt (National Center for Science and Engineering Statistics, 2018a). Financial and class barriers compound the challenges of less access to mentorship and research (Cohen & Garcia, 2008). URM students receive doctorate degrees at lower rates than non-URM students (National Center for Science and Engineering Statistics, 2018d; NSF, 2015) and they are more likely to have graduate debt and higher amounts owed across STEM fields, especially in social science-related STEM fields (National Center for Science and Engineering Statistics, 2018e). Hoppe and colleagues (2019) recently showed that African American/Black scientists pursue community and population health fields at higher rates than white scientists and that these fields have lower funding levels despite higher impact of publications. Moreover, Muslim scientists may practice riba, an Islamic practice in which loans with interest are avoided, which restricts how a scholar can pay for graduate schooling. Hinton and colleagues (2020) highlighted funding opportunities for scholar training across trajectories. Together, these studies suggest that giving underrepresented students the time and support to plan feasible paths and make informed decisions may help increase the percentage who complete advanced degrees.

Enrichment helped students self-define their own professional interests, paths, and goals, critical for developing a professional identity that integrates their personal and professional selves (Kasperiuniene & Zydziunaite, 2019). This is a large job when historical exclusion from a field limits representation and modeling of paths. Universities' Enrichment programs discussed themes of professional development, sociocultural dynamics, path representation, professional identity, and self-care more frequently than those at community colleges (Table 4). Perceived impacts of themes for students were comparable across university and community college sites, with the exception of professional development and path networking, which were rated higher at university sites where they were also more frequently discussed. Community colleges underscored the importance of team building (for building comfort with research and personnel) and supports for their students (facilitating students' learning about how and where to ask for help at their institutions). By placing these themes in context for students, Enrichment's reflection time and activities enabled students to relate research to their lives and identify practical strategies for negotiating barriers to biomedical careers that fit their interests and goals. Students at the primary site described high interest in gap years and funded postbaccalaureate programs for this reason, as they would provide additional facilitated time to explore their desired field while increasing research experience in that area. Our findings are consistent with those of Hinton and colleagues (2020), who underscored the importance of this transition time for URM students.

Enrichment Surfaces Implicit Curricula

In academia, personal relationships across authority lines provide the recommendations required for further education, as well as access to research jobs and key information on graduate programs and funding. To advance, undergraduates must build good relationships with people who have direct authority over them. However, we found formal scientific relationship expectations to be largely unknown to students, especially for first-generation college students. When asked in Enrichment to identify potential individuals they could ask to write them a letter of recommendation, several students did not identify their laboratory mentors despite working in their research laboratory for over 2 years. Likewise, students asked whether they must say "no" to coffee with a graduate student in their field who was their project supervisor and offered to talk with them about graduate programs. As academia has the second highest rate of sexual harassment of all workplace types, behind the military (Ilies, Hauserman, Schwochau, & Stibal, 2006), it is reasonable for students to question what constitutes an appropriate work environment. Coe and colleagues (2020) highlighted that mentoring and training regarding potential challenges that may arise in the workplace, including potential harassment, are needed for leadership development in academic medicine, particularly for URM individuals and women who face higher rates of harassment (National Academies of Sciences, Engineering, and Medicine, 2018). While sexual harassment was not reported by sites in our study, it often goes underreported in academic medicine due to concerns that it may threaten careers (Bates et al., 2018). Helping students recognize appropriate contexts for their research training and how to respond to potential challenges is critical for training in any field. For underrepresented undergraduates facing imposter syndrome (Bravata et al., 2020), academia places intense stress on becoming what is perceived to be desired by authority figures. Sites reported that their students consistently self-identified imposter syndrome as a problem, even as they gained research experience and credentials, including first-author publications. Our observations underscore a need to explicitly address hidden and implicit curricula with undergraduates as part of biomedical research training, which was also identified as a need for professional development training by both junior and senior biomedical faculty (Rubio et al., 2019) as well as undergraduate programs (Hinton et al., 2020; Merolla & Serpe, 2013; Toven-Lindsey, Levis-Fitzgerald, Barber, & Hasson, 2015). Together, these findings highlight a common need for instruction across all biomedical training levels. By creating space for students to talk together about navigating complex barriers and issues, we believe Enrichment structures are able to strengthen the professional development URM students need for advanced scientific careers.

Enrichment Highlights the Accessibility of Supports for Institutional Development

Underrepresented undergraduate researchers are both high-needs and high-performing students. Enrichment offers institutions insight about supports their students need, how accessible those supports are, and what institutional development efforts could better serve students—all factors highlighted by Estrada and colleagues (2016) as needed for improving URM student persistence in STEM. The structure of Enrichment typically incorporated instructional teams including faculty, staff, peer mentors, program alumni, and sometimes graduate or clinical students from nearby programs. Consistent staffing within instructional teams helped programs optimize Enrichment curricula over time and build trusting relationships with program students as well as relevant institutional faculty and staff. Staff often serve high-needs students, whereas faculty typically serve "high-performing" students, roles that were bridged by instructional teams in Enrichment. By using nonformal education structures to engage students as partners in the design of Enrichment content, students were able to have their needs met while programs gained rapid feedback about emergent student needs, available resources, accessibility of supports, and strategies for training diverse students in STEM and research. Enrichment also identified cross-institutional support options, such as accessible remote resources online, and potential strategies at the federal level, such as grantor flexibility for part-time enrollment to enable undergraduate trainees pursuing biomedical research programs to better cope with added life stressors that may arise without losing that term's financial support. One instructor described Enrichment as a "flashlight that illuminates the landscape" by pointing out challenges that all students face when trying to flourish in academia and research but are particularly prominent for underrepresented students. Therefore, examining supports that work for underrepresented populations in undergraduate biomedical research training programs may yield important insights for supporting more biomedical research trainees, akin to universal design supports in education (Al-Azawei, Serenelli, & Lundqvist, 2016).

Access Barriers to Enrichment

Common barriers to participating in Enrichment included intractable schedule conflicts (biomedical major prerequisite courses, solo caregiver role for children or disabled adults, survival-income work) and lack of transportation access. Sites reported off-campus events that required transportation and schedule coordination had lower attendance. The consistency of required Enrichment sessions at a regular time enhanced students' ability to plan their academic and research schedules. However, the balancing act of Enrichment was highlighted in data from student evaluations, where 45.6% of scholars indicated that if Enrichment was not mandatory, their participation in sessions would depend on the topic or the day/time. As most students agreed that Enrichment helped connect them with resources and that its materials and resources enhanced their learning, barriers surrounding access should be considered by future sites planning similar activities. Sites recommended that if attendance was required, it should be optional in midterm and finals weeks. All sites agreed that requiring students to produce material to be graded or judged was outside the nonformal structure and goals of Enrichment. At the primary site, universal access was provided through regular sessions, supplemental small groups at a different time, and a limited number of individual online make-up activities (supported by in-person appointment scheduling and online Enrichment resources). As online make-up work lacks community-building and peer-sharing components cited as helpful by program students, it was allowed to supplement, but not replace, in-person participation in peer sessions. Options added since the 30-month check-in included cross-cohort virtual sessions and weekly writing workshops.

Access barriers also existed for institutions: Small, distant community college sites reported limited direct exposure to research settings or well-equipped libraries of professional biomedical literature in diverse fields. They also reported access to fewer professionals to meet with their students. Partnerships across programs, departments, campuses, and institutions helped improve access. When students have equitable access and exposure to research training, programs and institutions can choose the best applicants rather than the applicants who had the best access (often those from the most privileged backgrounds).

Self-Care as a Strategy for Systemic Trauma

Self-care was given increased focus across sites as Enrichment evolved over time. Self-care is typically described as strategies for stress management and health (Butler, Carello, & Maguin, 2017; Myers et al., 2012; Roulston, Montgomery, Campbell, & Davidson, 2018). For underrepresented student researchers, self-care was discussed in the context of professional development, navigating the combination of systemic trauma (e.g., exclusion and abuse in systems; imposter syndrome; generational poverty; health disparities), and the typically poor work–life balance of academic, medical, and research cultures. In this population, students must recognize that needing self-care is not a personal failure and identifying strategies to cope is important for their professional development. Students in research training programs may stay in these programs despite high stress and lack of health supports because the opportunity to advance their career goals is too important to pass up. Students completing Enrichment reported that it made them feel supported, addressed their core needs, and had a large impact on their professional development.

Future Directions

Online sharing of resources across sites and greater use of teleconferencing is desired to increase access and reach to distant sites. Students at the primary site have requested podcasts, while instructional teams have requested digital platforms for sharing materials. Program alumni have asked to maintain contact with the program; a subset of alumni work for the primary institution's Enrichment on key tasks, such as building an online alumni network, creating online resources for cross-institutional remote chat, and curating access to a library of support materials. Students at multiple sites have piloted student-led projects as part of Enrichment, which offer new opportunities for developmental, cross-institutional networking. Students help define Enrichment, alumni develop its resources, while faculty and staff provide support and mentorship. Together, sustainability is improved and these developing professionals gain creative opportunities for publication, presentation, teaching, and other forms of curriculum vitae development.

Conclusion

Nonformal, interprofessional curricular structures support underrepresented students by offering a flexible and responsive environment for enhancing the biomedical research training of undergraduates. These findings are consistent with those from undergraduate and faculty STEM development programs that implement peer-enhanced supplemental instruction (Merolla & Serpe, 2013; Rubio et al., 2019; Toven-Lindsey et al., 2015). Enrichment engages diverse students in peer spaces and facilitates activities that give them a sense of ownership over the development of their professional identities, as well as practical tools to succeed in the academic and professional path of their choosing, on their own terms. The bidirectional benefits can be extended to programs and institutions that can use Enrichment-like structures to gain a greater understanding of how to support diverse student success in biomedical fields at their institutions. These practices align with recommended approaches for ultimately improving URM student persistence in STEM (Estrada et al., 2016).

Acknowledgments

Special thanks to the students/trainees and faculty who participated in this NIH Diversity Program Consortium study and supported Enrichment as speakers, peer mentors, and graduate near-peer mentors, particularly Taylor Vega (MD/MCR student) and Sunil Joshi (MD/PhD student). The research reported in this publication was supported by the National Institutes of Health Common Fund and Office of Scientific Workforce Diversity under three linked awards (RL5GM118963, TL4GM118965, and UL1GM118964) and a Science Education Partnership Award (R25GM129840 to LKM) administered by the National Institute of General Medical Sciences. The work is solely the responsibility of the authors and does not necessarily represent the official view of the National Institutes of Health. The authors have no conflicts of interest to report. No nonhuman animal studies were carried out by the authors for this study.

Appendix

Appendix 1. Origin and early structure of Enrichment.

Start of student experience. A program orientation event at the primary site welcomed new student participants from all sites. This event responded to the recognized need to create a supportive environment for students, allow them to connect with peers, learn about campus services and supports, explore professional development opportunities, and engage in activities and events fostering a sense of shared purpose and community.
Origin of enrichment. At the primary site, an EXITO academic professional and the program's academic advisor created and led optional group activities in the first year (cohort 1) to help students network with campus professionals of interest, provide a forum to share information conveniently, and provide a sense of structure and belonging for the program, especially in its first year. Early student feedback suggested these activities were very important, but that most program participants had too many competing responsibilities to attend optional events. In year 2, EXITO leadership defined Enrichment as an official program intervention, with all sites needing some type of student Enrichment, though the form, content, and definition of Enrichment were left up to each site. Activities at the primary site were converted into a regular schedule of required weekly sessions for cohorts 1 and 2, run by a faculty lead. A small working group of faculty and staff at the primary institution and a transfer partner community college provided support for this transition; the group had come together to identify common barriers for underrepresented undergraduates, and members were experienced in direct support roles with URM students. The chair of the working group, a non-faculty academic professional with teaching experience, became the coordinator of Enrichment. As university faculty availability varies year to year, including an instructor/coordinator in an Academic Professional staff role provided program consistency. During year 2, Enrichment sessions at the primary site were on Fridays for both cohorts, sometimes run as a single session. By the start of year 3, the primary site instituted separate Enrichment sessions for each cohort with three new faculty leads and the coordinator.

Appendix 2. Prompts used for site evaluation of Enrichment.

Sites were sent a digital document asking about Enrichment implementation at their institution, with five prompts (April 2018):

1. Who does Scholar Enrichment at your institution?
2. What are the "nuts and bolts" of your Scholar Enrichment? (how often, format(s), etc.)
3. What are your goals?"; "What do you think are the core responsibilities of Enrichment?

4. If those are the core responsibilities, what are your primary learning objectives (L.O.)?;
5. If you were going to be assessed on these L.O.s, what would you change or what would you need to feel confident?.

Follow-up prompts (November 2019):
6. What have you learned about offering enrichment to your students?
7. What feedback have you received from students about enrichment thus far? (course evaluations, word of mouth, anecdotes, etc.)
8. Anything else you want us to know?

Member checking prompts (October 2020):
9. Which areas do you cover in your site's enrichment (0 = not at all; 100= core component discussed frequently)
10. Please rate each Enrichment theme for its IMPACT on scholars at your site. 0 = no impact; 100 = maximal impact.
11. Any feedback on the above?

Appendix 3. Enrichment "course" evaluation used to measure student impact at the primary university.

Informal Course Evaluation about Enrichment

This evaluation asks about <u>enrichment</u> (not summer induction or immersion workshops)

(Check one)

Started [program] at [primary institution] ______
Started [program] at another institution _____

Question	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
1. Enrichment as a whole was well organized						
2. The materials and resources of enrichment enhanced my learning						
3. Enrichment helped me understand career path options						
4. Enrichment helped strengthen my writing						
5. Enrichment helped connect me with resources						
6. Enrichment made me feel supported						
7. Enrichment had a large impact on my professional development						
8. Enrichment addressed my core needs						

9 In what area(s) has enrichment helped you most?

____

10. Where did you wish enrichment helped you more?

____

11. On a scale of 1-10, please rate how you felt/feel about Enrichment being required?

Question	Scale	Your rating (1-10)
When you <u>first started</u> enrichment, how did you feel about it being required?	1 (strongly disliked) to 10 (strongly liked)	_______

Did this change? For example, how do you feel now about it being required?	1 (strongly dislike) to 10 (strongly like)	________

12. Would you have come to enrichment if it wasn't required?

____

12a. How often have you physically came to enrichment this year?
Most of time Some of the time Occasionally Rarely (used supplemental/makeup)

13. Thinking about your needs over the past few years, what should ENRICHMENT be sure to cover during each of these years? (e.g., think CV, personal statements, admissions test awareness, career path support, networking, interview support, etc.) If there were items that you <u>wanted</u> during these years that <u>were not covered</u>, please mark those items with an **asterisk***.

Sophomore Year	Junior Year	Senior Year

14. In #13 above, circle your top three biggest needs

Instructor Evaluation

Answer the following questions for Instructor #1:

Question	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
15. The instructor was knowledgeable about the subject						
16. The instructor was well prepared						
17. The instructor's strategies stimulated my thinking and inquiry						
18. The instructor was supportive of diverse cultures and viewpoints						
19. I received meaningful and timely feedback from the instructor						
20. The instructor helped me to achieve my goals						
21. Overall, I rate this instructor highly						

22. Instructor #1's biggest strengths:

____

23. Instructor #1's room for growth:

____

Answer the following questions for Instructor #2:

Question	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
24. The instructor was knowledgeabl dde about the subject						
25. The instructor was well prepared						
26. The instructor's strategies stimulated my thinking and inquiry						
27. The instructor was supportive of diverse cultures and viewpoints						
28. I received meaningful and timely feedback from the instructor						
29. The instructor helped me to achieve my goals						
30. Overall, I rate this instructor highly						

31. Instructor #2's biggest strengths:

____

32. Instructor #2's room for growth:

____

33. If you were a transfer student, where did enrichment help you most. If there are there other ways that enrichment could have supported you, please describe and mark with an asterisk?

34. **Anything else you want EXITO to know about ENRICHMENT:**

Appendix 4. Data definitions and example quotes of observed themes reported by Enrichment sites.

Code	Data Definition	Example Quote(s)
Instructor	Describes who does Scholar Enrichment at the institution (for example, solo instructor, team instruction, is the instructor level a faculty member or staff)	• "Teaching teams: [one lead] for each cohort, one coordinator on all the teams, and peer mentors (1st year) or grad students (years 2&3)." "Teaching teams meet every other week to plan the next sessions; all teams meet together once a term." -Urban University
Structure and Format	Describes what the "nuts and bolts" of each site's scholar Enrichment, such as frequency per term, duration, and general format through inclusion of speakers, etc. Subthemes observed:	• **Frequency and Duration**:"Meet weekly for 1.5 hours; First 30 minutes: students present on their work; other students critique the presentation in writing [students not yet placed in labs present on interests]. Remaining hour: interactive discussions on "Hidden curriculum" topics, such as how to communicate research with potential funders, faculty, conference attendees, friends and family; where to find funding and research opportunities outside of [institution]; designing and updating CV; writing manuscripts; presentation tips; code switching; identifying research passion; balancing life/work/research/classes. –Urban university • **Audience and Attendance** "Program stability may require a minimum of 10-15 students; goals are difficult to meet with <6 students in a session." –Urban Community College • **Approach to content** "As the only regular in-person meeting point for Scholars at [site], Enrichment tends to handle a variety of other program needs/activities." – Urban university • **Format and Activities** "Content: lecture, group activities, panels/mixers. Students prefer interactive formats--practice skills and talk with professionals."-Urban university • **Instructional supports/ online resources** "[Three scientists] conducted a panel-style presentation on their respective research followed by a question and answer session. [Scholars at another distant institution] were able to view the presentation via zoom video conferencing. – Partner university
Learning objectives	Sites defined primary learning objectives for their students based on defined goals. Learning objectives often mirrored the goals, therefore, the code "learning objectives" was applied to individual child codes under goals and objectives to identify where alignment most frequently took place.	• "Engage in collaborative and interdisciplinary approaches and teamwork for improving population health."-Partner university • "Collaborate with others from diverse backgrounds in addressing health disparities and inequities."-Partner university • "Explain the influence that science and technology have on individual and population health."-Partner university • "Critically analyze implicit bias and the barriers to equity" –Primary university
Measurement and Outcomes	Sites described approaches for evaluating learning objectives and	• "We have incorporated a lot of formative evaluation, for each special event, for important topics we are introducing for the first time, or at the end of many terms.[…] We use this data to make improvements to

	outcomes observed. They also described strength of evidence and what support would be needed to feel confident in their evaluation.	enrichment and address remaining gaps in the next session. One of the things most important is that students feel that their voices are being heard, which makes the data quality better (defined by more descriptive open ended responses). Students knowing that we care about their responses and are using their data has increased their feedback to us." – Primary university • "Gather pre-Enrichment and post-Enrichment data on Scholar use of: faculty office hours, accessing [disability resource center], accessing institutional support services/campus resources."-Urban community college
Barriers	Barriers described to implementing enrichment (student, institutional, geographical, etc.)	• "Access to speakers has been very sparse on island so we typically have 1 or 2 presentations per semester." – Distant community college • "We also talk about the transfer process often and what it looks like when a student is juggling a full course load and [program] tasks, along with outside responsibilities. Our demographic at the community college includes students that have a wide range in their preferred number of credits per term, either due to work, family, or educational needs. Transitioning into [training program] and the required continuous full time (FT) status does cause anxiety in some students, so we try to talk about that in advance. We also find that having early information on campus resources (financial aid, [disability research center], childcare, etc.) at both [community college] and [primary university] has been critical for students. – Urban community college site. • "While the focus is still on both (i) enrichment and (ii) academic/curricular goals, the weekly hour-long sessions have organically grown to be more focused on enrichment rather than the material in the class modules (that is, a lesser focus on the academic and curricular goals of the class). This has been the result of a better understanding of what would most benefit scholars at this early stage of their research careers." – Urban community college • Scheduling and transportation are still challenging. Enthusiasm seems higher so far." –Urban community college
Implementation Solutions	Describes approaches that programs have used or ideas that could be tested. Includes description of other existing opportunities that could be synergistic or help enrichment take hold institutionally.	• In the fall semester, most enrichment activities have been incorporated into the Gateway [to Research] course. – Distant community college • Considering institutionalization [of Enrichment] as a student club; the student clubs organization has funding but consistent leadership is a challenge. – Urban community college • "Students won't attend unless they are held accountable for attendance. Through a [program] meeting at [a scientific] meeting, [instructor] found that other schools offer 0-credit classes that go on the transcript but are essentially free; students receive a pass/fail grade. We will explore this."-Partner University • In terms of outcomes, student satisfaction with enrichment is a low-hanging but critical outcome. If they don't feel that their needs are being met, enrichment can feel like another thing they have to do, which is hard when scholars are already so busy. Building in time for scholars to talk with each other is one easy way for increasing satisfaction, another is helping with their writing, as well as giving opportunities to meet professionals. Focusing solely on skills development and attainment can leave some scholars who have not

		solidified their professional identity feeling left behind. Interspersing professional identity development discussions is helpful, particularly when time horizons are discussed in the context of important considerations (e.g., financial, family in town, caring for elders, etc.), which can influence time until pursuing graduate school and if that path is feasible for them in the next five years. Many students are highly interested, but the financial barriers are significant. Focusing on post-bacc programs is great because it's a way for students to gain protected time in a mentored environment, especially when placements are funded."-Primary university • "[S]tudents are motivated to continue in their academic programs. These activities create a strong learning environment where interaction among a diverse group of college students takes place. This builds a sense of belonging and sense of community among the [program] Scholars." – Distant community college"
Change over time	Child codes of "change" or "no change" applied to components that evolved over the study period.	• "In the last consortium meeting held [at primary university] in March 2019, we learned that Enrichment activities don't have to be solely focused on research – but rather being a successful scholar. Up until that point, we felt that the lack of opportunities to provide exposure to research really held us back from providing what we thought were "enrichment" activities. We realized that we did in fact provide enrichment in other ways that we weren't accounting for. For example, all of our scholars have to take a prerequisite course prior to the Gateway Course called College Success. College Success covers many Enrichment activities like time management, being professional, etc. However, after the Gateway Course, we have now decided to have them participate in at least 3-4 of [site's] Student Success Series. – Distant community college • "Allowing scholars to attend other cohorts' sessions (and being explicit which are open to other scholars) has been reviewed favorably. Transfer students get more of the professional development skills that sophomore Enrichment covers. Students get more autonomy in picking sessions that would be beneficial to them. – Primary university • "Offering students flexibility in how to receive the content is highly impactful. Regular sessions, supplemental sessions (smaller ~4-8 students with facilitator), online make up. Students want to get out of enrichment because it frees up time, but after going through it, students report that the time spent was valuable in helping to put their training and research experiences in perspective. The cohort building piece is significant."-Primary university

Appendix 5. Core themes and sub-themes described by sites.

Theme 1. Cohort and team-building: All sites described building an interactive group environment that would foster a "sense of relatedness", "sense of belonging", or "sense of community." Of the 50 quotes in this theme, 78% mentioned '*Group conversations to support students' professional and personal growth*.' They referred to students participating in conversations together, reflecting with each other on their academic and scientific experiences. '*Program and/or discipline cohort building*' was mentioned in 24% of code applications and described supporting students' sense of community/belonging with their program, with others in their cohort year (year of training program), or with their professional area of interest. The primary site reported contact across cohort years was highly meaningful for students, particularly when student numbers in an area may be limited. Less common academic and research disciplines (e.g., speech-language pathology, physical therapy, community-based participatory research) and demographics (e.g. Muslim, trans person, intersectionality between race/gender) were not always represented within a student's official cohort, even in the largest program in the consortium. Similar students with different levels of experience (near-peers) could overcome this barrier in cross-cohort sessions or informal discussions, where they would share information about successful strategies.

'Proxy for support' was described in 24% of this theme's code applications and referred to sites using cohort/near-peer networking and group activity as a proxy for missing or inadequate support structures. Codes described peer and near-peer discussions in which a specific common struggle was revealed, identifying a previously unrecognized need for URMs in the program. The students would then support each other, share information on available options, and/or advocate with the program or institution for a specific improvement. Institutions and the EXITO program were able to use Enrichment to identify common challenges faced by their underrepresented student populations rather than responding to these issues as individual personal problems.

Theme 2: Professional identity. A total of 93 quotes described professional identity. It was viewed from one external perspective (negotiation) and four internal perspectives that described self-development. *'Presenting oneself,'* the external perspective, was the most common professional identity sub-theme, cited in 51% of these quotes. It was most often described in the context of students' professional portfolio materials (i.e., personal statements, cover letters, curriculum vitae, resumes, and application essays that ask students to describe their identity, experience, and goals). Activities in this area addressed implicit cultural information and technical skills to self-represent as an underrepresented professional in academia and research, particularly in the contexts that control access to advanced degrees. For example, they included discussion and practice of negotiation, conference networking, graduate and professional interviews, and technical information and strategic disclosure skills for the written documents required to access graduate and professional programs, secure funds to finish college, and apply to research jobs.

Internal perspectives (i.e., 'What could I look like as a professional or researcher?') described how scholars viewed themselves, identified their goals, and understood the training they wanted from the educational system. *'Modeling who does science'* was represented in 49% of quotes. It described helping students understand the diversity of people involved in science, what researchers care about, and what limitations in science and research careers may exist, even for successful scientists. *"Reflection time"* was represented in 39% of professional identity quotes. Sites reported that helping students understand that identity development takes years of reflection was important. Enrichment provided this time to help students integrate their developing research skills (e.g., ethical considerations, data management), with their goals and values into self-directed professional identities. *'Recognizing gaps in professional preparation'* was described in 35% of this theme's quotes. It referred to supporting students' ability to identify gaps in their knowledge and skills as opportunities for growth and future training (rather than reinforcing imposter syndrome often experienced by URMs (Bravata et al., 2020). Emphasizing strategies for persistence after failure, which occurs frequently in science, was identified as critical. *'Sense of Belonging'*, described in 24% of quotes, referred to a focus on showcasing similarities among program students across biomedical fields. Sites reported that sharing common experiences helped students understand norms and expectations. For example, asking questions when having limited information or concerns was emphasized as an expected norm in biomedical research training and careers, rather than inappropriate behavior. Students helped each other understand these expectations.

Theme 3: Research skills. General research skills were cited in 43% of the 91 code applications. Specific research skills were categorized into six areas: *communication skills, skills for navigating research careers, critical thinking, research methodology, information literacy, and research ethics*. *'Communication skills'* were cited in 44% of code applications and referred to improving scientific writing, both research communication (e.g., scientific presentations, informal discussions about research) and professional documentation (e.g., personal statements, curriculum vitae, business cards for research event networking). *'Skills to navigate research'* was cited in 32% of quotes and described skills that students could use to navigate research careers, such as how to find mentors or additional training in an area. *'Critical thinking'* was cited in 16% of quotes and referred to helping scholars' interpret research literature and findings, identify limitations, and consider next steps in the experimental process. *'Research methodology'* skills were also cited in 16% of quotes, and referred to access to learning quantitative and qualitative methodologies, most often statistical and data management skills to support scholars in their research. *'Information literacy'* skills (15%) described teaching students how to conduct literature searches, evaluate the credibility of information sources, and how to search for information to inform their career development. For example, online searches of graduate programs, training opportunities (e.g., post-baccalaureate programs, summer research programs), and funding opportunities (e.g., scholarships, grants) all were considered 'information literacy'. Finally, *'research ethics'* (8% of code applications) was cited as an integration of research ethics and principles into scholars' identities as researchers and biomedical professionals.

Theme 4: Path representation and networking. A total of 76 code applications described path representation and networking in the context of allowing students to identify scientific professionals and career paths of interest to support students' autonomy in making their decisions. *'Available paths'* was most commonly cited (64% of code applications) and referred to supporting student networking to meet professionals who could help students identify or solidify their possible career paths. *'Social connections'* was equally mentioned (62% of code applications) and referred to social interactions independent of a desired path, which helped students strengthen communication skills inside and outside of their desired field. Professional networking was described as being intimidating for some students, particularly those who may be introverted or have social anxiety. In such cases, Enrichment sites offered strategies and tips (such as example email prompts or small group work) that helped students to overcome networking anxiety. Code applications for *'path representation'* were categorized into internal versus external components for understanding a path. Approximately 22% of code applications described networking in the internal context of helping scholars *"build confidence in pursuing their desired path;"* such as conversations with professionals and near-peers who could represent what a desired path could look like, allowing scholars to better visualize their own career in that area. In contrast, 17% of quotes described using networking in the external context, as a way for scholars to understand what portfolio items would be needed in order to pursue that path of interest (e.g. GRE/MCAT, clinical shadowing, personal statement, etc.). Since underrepresented students face systemic oppression in educational systems, both internal and external supports helped students visualize their belonging within a field. Sites reported that networking with diverse professionals aided students' understanding of how their values could be integrated within that career path, and how their own understanding related to the external steps required to get there.

Theme 5: Professional development. This theme included both personal growth (beliefs) and accrual of professional skills. Professional development was described in 43 quotes, both generally (44% of code applications) and across specific sub-themes. For example, *'Specific skills'* (e.g., time management, study skills, financial skills, leadership skills) were referenced in 21% of quotes. These skills also included work-life balance and professional etiquette (such as conference dress codes, use of business cards, etc.). *'Self-care and emotional intelligence'* were described in 21% of quotes, with emotional intelligence referring to the context of navigating interpersonal relationships in professional environments. As underrepresented students face more barriers and inequities, the personal toll when navigating professional environments may be higher for these students, which is supported by our data showing that emotional intelligence and self-care were often mentioned together. Also described in the context of professional development, *'Support of self-beliefs'* referred to raising students' self-awareness and belief that they could pursue and be successful in biomedical research paths. Imposter syndrome was described in this context, which together with self-beliefs comprised 21% of professional development code applications. Finally, *'Self-advocacy'* was described in 16% of quotes and referred to negotiation skills and how to navigate conflict on behalf of oneself. Self-advocacy may serve as one output of scholars' gaining emotional intelligence, though these sub-themes were only mentioned together once when approaches for self-care were described in the context of "life skills that will help the student cope with the demanding expectations of their educational and career paths, given the additional responsibilities and pressures specific to their underrepresented status."

Theme 6: Research relevance. Societal and personal impacts were described across 28 code applications describing research relevance. Societal impacts (64% of *'research relevance'* code applications) described helping scholars expand their perspectives to see populations in need of additional research, including those facing economic inequities and health disparities. Sites also described how to address real problems facing their communities and the world today. Social responsibility was particularly impactful for one university that had students complete outreach activities to better understand health and economic disparities faced by homeless individuals living in their region, as they cited the work supported students' visualization of the diverse, multidisciplinary factors involved in research. Approximately 50% of *'research relevance'* code applications described helping students see the personal relevance of research, including what research could look like for them as scientists.

Theme 7: Research Exposure. Sites described exposure to *"types of research"* and *"research culture"* across 29 quotes. *'Types of research'* was described most frequently in these quotes (79%). It referred to exposing students to the different types of research that they could potentially do. Sites provided research exposure through visiting scientist presentations, journal clubs, and general discussions. Of note, access to scientists/speakers was more challenging for distant community colleges. Exposure to research culture (45% of research exposure quotes) described providing scholars with exposure to research environments and addressed questions such as who does the work, what laboratories look like, and the range of skills and roles typically needed. Approximately 24% of quotes applied both type and culture codes when describing *'research exposure'*. When planning Enrichment, students' research exposure and desired career paths were often informed together, which influenced instructors' sense of what additional activities and exposures were needed.

Theme 8: Institutional infrastructure. Referenced in 21 quotes, sites described this code from two perspectives. *'Improving student/faculty/institutional relationships'* was described in more than 2/3 of quotes (67%) and highlighted that Enrichment supported relationship-building between students and faculty, and "often fulfill[ed] a mentorship role." Sites also reported that their program's students helped to build connections across their institution's scientific disciplines or research programs, which was visible during Enrichment's peer sharing sessions. Sites offered that the program's students served as a 'scientific pollinator' across scientific areas in ways that enhanced networking and communication at their site. This sharing is important for institutions, as 19% of code applications cited that the credibility of their institution improves when program students are successful, highlighting the mutual benefits for both students and institutions. *'Facilitating access to institutional supports'* was described in 62% of institutional infrastructure quotes. It referenced sites' use of Enrichment to understand early indicators of student needs. Sites reported that Enrichment helped institutions change (or plan for change) responsively and in an evidence-based manner. Some sites were working to institutionalize instructional components to make Enrichment available to more students at their institution.

Theme 9: Sociocultural dynamics. Sites described a focus on the sociocultural dynamics within academia and research across 40 quotes. *'Navigating academic/research cultures and teaching hidden curriculum'* was most prevalent (70% of code applications) and described processes for underrepresented students to learn about academic, research, and workplace cultures, as well as their often unspoken norms, values, and expectations. *'Inequities faced by underrepresented students'* comprised 35% of code applications and included *'Systemic barriers and disparities'* (22.5%) that people of color and other marginalized groups disproportionately face, as well as strategies for *'Responding to Bias/Microaggressions'* (12.5%) in successful ways that support students' personal and professional selves. *'Diverse representation'* was described in 23% of code applications and referred to the diversity of research teams (or lack thereof) and the benefits of including diverse experiences and cultural perspectives for strengthening teams. Finally, *"Supporting communication across diverse perspectives"* was cited least frequently (15%). It referred to understanding sociocultural perspectives within a scientific discipline or across academic levels by talking with diverse professionals and peers. The quote below offers an overarching reason why it matters to help underrepresented students navigate these sociocultural dynamics and academic cultures.

"Professional development skills are part of a hidden curriculum that is not taught traditionally in the classroom and is essential for career development. To provide skills in scientific and professional development, sophomore enrichment is divided into 3 areas in the sophomore year each with its own learning outcomes. Area 1 focuses on student development and self-efficacy as biomedical researchers. Here students are taught skills in overcoming personal barriers such as self-care, imposter syndrome and microaggressions as well as systematic barriers that impedes success for underrepresented students. They work on deconstructing the idea of what a scientist should look like and there is an emphasis on the importance of diverse people in STEM and the values they bring into research that has a global impact on human health and the community. We work with students to understand the importance of mentors, advisors, and advocates in the development of their career and professional identity. Students also incorporate their own personal life experiences into constructing their personal identity and we work with them to build resilience through skills aimed at improving their self-efficacy, confidence, and strong emotional intelligence. Lastly, we provide a space to discuss career pathways to support students as they align their personal goals with their development in biomedical research. Area 2 focuses on the development of their professional identity through skills that are part of a hidden curriculum. These skills include effective communication, time management, networking, and negotiation strategies. Area 3 focuses on skills that can be applied

in a research learning community such as presentation skills, database management, literature reading and writing. In addition, there is a strong emphasis on development of interpersonal skills that are necessary for working in a team lead research learning community. These interpersonal skills include working effectively in teams, building group cohesiveness, and handling conflict within group dynamics. Over the year enrichment and peer mentors were able to help provide these essential skills for student success and development as professionals in biomedical research." –Primary University

Theme 10: Supports. A total of 32 quotes described helping students navigate supports available to them. *'Checking in for support and emergent student needs'* was a major subtheme, representing 74% of code attributions. It described Enrichment as a place for the program to check in with students, understand needs, offer support, and refer students to resources. Several sites described Enrichment as a way for their institutions to learn about emergent student needs so they could proactively develop structures to help current and/or future students. *'Accessing supports and normalizing the process'* referred to helping students learn how to identify, access, and navigate supports (35% of code applications), such as financial aid, student health, and disability accommodations. Approximately 15% of all *"Support"* quotes described using Enrichment to help scholars learn coping skills and stress management techniques. Likewise, 15% of these quotes described an expressed intention by sites to normalize the idea of people in academia asking for help and needing support at times, with all sites who described normalization also providing guidance on how to access support resources.

Theme 11: Knowledge and self-efficacy. The development of scholars' knowledge and self-efficacy was described by 6 of the 9 sites in only 10 quotes over two equally referenced subthemes. *'Knowledge of paths or resources'* (70% of quotes) referred to the accrual of knowledge that supported scholars' career path decisions, content knowledge in specific paths, or procedural knowledge about how to pursue paths. The accrual of knowledge was viewed by one instructor in the context of students' role shift into developing professionals. *'Building competence of program students'* (60% of quotes) was described in the context of self-efficacy. It referred to helping students believe that they could pursue their desired goals (e.g., academics, research, etc).

Theme 12: Self-care. Though described in only 11 quotes, self-care was a growing emphasis for sites over the 18-month study period and was identified by 5 of 9 sites as a critical need for supporting student professional development in research environments. Sites described a need for instructors to model self-care and work-life balance, as it helped inform students how to manage self-care in academia and whether a research career could work for them. Sites also described that helping students incorporate self-care into their routines was important for preventing burnout while supporting mental health. Finally, self-care included practices that students could use themselves, as well as teaching them peer-to-peer, and recognizing when additional support may be needed.

Appendix 6. Thematic analysis of learning objectives, structure and format, barriers, implementation solutions, and key changes to Enrichment across sites.

Learning Objectives

Bloom's taxonomy describes six levels of learning objectives that range from lowest (level 1) to highest (level 6) cognitive order: *remember, understand, apply, analyze, evaluate, and create* (Adams, 2015). This taxonomy was used to sub-code 115 quotes describing diverse learning objectives to find common elements. In learning objectives, sites described four knowledge types described by Adams (2015) including "factual (terminology and discrete facts); conceptual (categories, theories, principles, and models); procedural (knowledge of a technique, process, or methodology); and metacognitive (including self-assessment ability and knowledge of various learning skills and techniques)."

Structure and format

Structure and format describes logistics and common practices for running an Enrichment program, including instruction; frequency and duration; audience and attendance; approach to content; activities; and instructional supports and online resources.

Instruction. The facilitation of Enrichment varied across sites, with "instructor" comprising both faculty and academic professional staff. Most common was a faculty instructor 'lead' working with a team (5 of 9 sites cited this approach; 2 of 3 universities, 2 of 4 urban community colleges, and 1 of 2 distant community colleges). "Team" referred to any combination of staff, other faculty, undergraduate peer mentors, and graduate students involved with Enrichment activities; typically 1-2 people, with one section at the primary university having 6 peer mentors. Teams without a defined "lead" were used at two sites (1 distant university had 4 team members and 1 urban community college had 2 team members). A single instructor led Enrichment at both distant community colleges. Consistency in instructors was a challenge at some sites and changed frequently as a result, particularly in cases where Enrichment depended on faculty with other teaching and/or research responsibilities. Financially supporting a dedicated person's effort (Full Time Equivalent, FTE, or portion of a team's FTE) enabled sites to build consistency in instruction, and identify and implement best practices based on participant feedback. Consistency also helped to build trust between students and instructors. Students built long-term relationships with stable instructors that often served as the basis for obtaining letters of recommendation. One partner university site was able to leverage funding from another research grant to support instructor FTE to implement Enrichment for students across both research training programs.

Frequency and duration. Two universities held 90 minute sessions. Three of four urban community colleges and one distant community college offered 60 minute weekly sessions. Duration at the remaining sites varied based on the event. Instructors who used 90 minute sessions identified them as highly valuable for workshops (e.g., informational, discussion, or practice time). Two universities with 90 minute sessions offered them weekly with attendance required as part of program participation. One urban community college held enrichment events once or twice per quarter, and one partner university held events once or twice per semester. Two different structural challenges appeared:

1) *Large required programs*. The primary university served more than 100 participants per term. It established three separate cohorts, and tied frequency to student level (i.e., sophomore, junior, senior), requiring weekly sessions (10/quarter) in the first year of training (sophomore) and every other week (5/quarter) for students in the last two years of training since students also had required research hours to complete in laboratories. Supplemental options were offered for universal access and contact across levels.
2) *Small isolated programs*. Enrichment at both distant community colleges was variable in frequency and varied in the types of on-campus sessions and off-campus activities included. Programs had limited access to professionals beyond the core instructor/team. Some smaller sites with limited numbers of students and faculty/staff leveraged resources by integrating aspects of Gateway course instruction, Enrichment, and Mentoring. Student issues and programmatic findings were consistent across sites, regardless of whether Enrichment activities were combined with other program elements or offered as stand-alone options.

Audience and attendance. All sites identified their Enrichment as interprofessional. Biomedical research training programs serve majors in natural science, social science, and technical STEM fields, who aspire to both academic and professional degree paths. Sites reported interprofessional instruction facilitated students' self-discovery while making it easier to implement Enrichment at their institutions. The interprofessional setting provided a critical mass of student peers, while keeping implementation and staffing costs low by serving multiple majors and degree paths. Both university and community college partner sites reported a minimum number of students attending Enrichment was needed for sessions to feel worthwhile to students. Student attendance was particularly important for institutions with smaller or fewer cohorts, such as community colleges where attendance lasts for two years; these institutions never had more than two cohorts at once. Partnering with other STEM research training programs can improve student attendance and provide a critical mass of students.

Approach to content. Overall, sites described Enrichment as a "flexible container" that could offer a range of programmatic content that was responsive to emerging issues and needs. Enrichment content included knowledge transfer through didactic sessions, skill development, portfolio creation, communication about the research training program logistics (i.e., announcements, expectations, deadlines, resources), and served as a dedicated time/place for students to talk with each other and meet professionals. On rare occasions, it offered a group setting for trauma support (e.g., student death, natural disaster). Most sites highlighted that the content of their Enrichment was student-driven or student-informed. Students co-created what they wanted to learn (informing both choice and timing of topics) and identified existing gaps in their training as a group. Students used Enrichment to raise emergent issues for themselves and their peers, such as barriers faced in academia and research. As instructional leads were situated to document issues and support collective change, Enrichment enabled students to get their needs met as individuals while informing programmatic and/or institutional support gaps. At the primary site, content became scaffolded to programmatic year over the 18-month study period, enabling topic areas to differ for sophomores, juniors, and seniors while still being responsive to the needs of students who rarely have an academic and career "straight track." Cross-cohort sessions supported students' ability to form groups based on other factors than program year (i.e. identity, degree/career interest), and share skills, resources, and path options.

Format and activities. Formats varied but were highly interactive. Key activities focused around two themes: 'dedicated time for personal reflection/student sharing' (32% of 'format' code applications) and 'specific scientific activities' (28% of 'format' code applications). The latter, scientific activities, included scientist talks, panels and mixers, science pubs, journal clubs, ethics discussions, and "lab boot camps" that gave opportunities to practice basic lab techniques. Enrichment activities often integrated both themes. For example, one partner university offered a science non-fiction book club and student-led movie nights; another used a community service outreach project with a local homeless coalition to understand health disparities in practice; other institutions gave portfolio writing workshops (i.e., personal statement, curriculum vitae, resume) and tutor training. Sites reported that institutional collaborations across their scientific training programs, and leveraging existing resources, were effective to create Enrichment activities. Partnering with other institutional programs (grant-funded or institutionally funded) enabled sites to extend offerings to students (e.g., tutoring, professional development supports, and writing support). For example, an urban community college and a distant community college both offered aspects of program Enrichment through attendance at events outside the program: research symposia/conferences, and an institution's existing 'Scholar Success" workshop series. Two distant sites, a university and a community college, collaborated with each other to create a scientist panel [on one island] that was video-conferenced for students at another island. An example of how these formats and activities evolved is described below:

> *"The structure of enrichment during our sessions have also evolved from passive teaching methods which include lecture and reading to participatory methods that involved student engagement through role playing, small group discussion, and practice by doing. We curated opportunities for students to practice professional development skills such as active listening, emotional intelligence, and communication skills through EXITO sponsored panels, networking events, and community building through engagement with each other within the cohort and with peer mentors. Overall the cohort community building over these years since 2017 has strengthened and Enrichment attendance also improved dramatically." -Primary university*

Instructional supports and online resources. Online platforms (e.g., Google Docs, online course management platforms) enabled sites to share announcements, materials, resources, and writing/portfolio examples with students. Other sites used email as their primary communication method. To meet access needs, one urban community college used calendar polling software to find group meeting times, while the primary university used meeting booking software to support 1:1 student meetings. Several sites described lack of these instructional supports as barriers to implementing Enrichment (see *Barriers* below). While online platform resources were created for immediate needs, teams across sites were interested in their potential to share content to support student, alumni, and faculty/staff development across institutions.

<u>Measurement and outcomes</u>

Sites reported measurement outcomes as well as areas where they would feel strong or weak in evaluating learning objectives. Of the 47 quotes, over half (51%) described evaluation approaches for measuring impact of their Enrichment activities, such as event evaluations for formative feedback, and term evaluations for summative feedback. Sites offered suggestions for other evaluation approaches, such as written student reflections that could be analyzed for learning objectives and development of professional identity. *'Professional development'* was identified as a desired measurement outcome in 32% of quotes. It included the perceived value of supporting students' professional development, particularly professional development skills such as cultural knowledge of academic and research cultures and their norms, professional writing skills to articulate a professional identity, and implicit curriculum on how to access support systems. *'Authentic conversations with faculty, staff, visiting scientists, and peers'* was described as an important outcome in 19% of code applications. It referred to Enrichment providing dedicated time and space to have meaningful conversations with others about science, research, and path progression. *'Student satisfaction and appreciation'* was also referenced in 19% of quotes and described student satisfaction as an important early indicator for gauging the effectiveness of Enrichment for students. Partner sites sent student quotes, which referenced student satisfaction and appreciation for Enrichment. One student from an urban community college described the personal impact of Enrichment:

> *"The enrichment sessions at [my urban community college] have been very valuable to me! It is like a check in with reality to think about the future and realize the things I need to do now to prepare for that and increase my success rate thanks to the support team I have. Sometimes life gets really busy but meeting every Friday reminds me that the school/life stresses is a part of the journey that I am on as I am working towards my career. Like a light at the end of the tunnel. I believe the honesty and openness of the team is very helpful, being able to have discussions about what to expect, good or bad, helps me not worry as much. I do think that the structure...could be a little bit better. Maybe a little less ethics and a little more personal development, although we are learning/growing through our discussions, maybe more CV writing or negotiation techniques. There is just not*

> *much time through this class to learn everything but I think our campus EXITO program should keep in contact with the EXITO Enrichment program at Portland State University to make sure that we are all on the same page and communicating with each other so we don't learn things next year when we transfer that we've already learned this year and so we don't miss anything that they've covered this year."*

Finally, *'logistics and student-driven approaches matter'* was mentioned least frequently (13%), but was described by sites as being very important for Enrichment and its outcomes. For example, barriers to attendance (e.g., travel to events) or methods to boost the number of students attending (e.g., attendance requirements or other options) were cited as measurement opportunities for evaluation.

<u>Barriers</u>

Across the nine sites describing Enrichment over two time points, a total of 24 quotes described barriers experienced by program students which surfaced through Enrichment. *'Access to scientists/challenges with travel logistics'* was cited exclusively by community college partners (38% of 'barriers' quotes). It referred to students having inadequate access to scientists who could speak with them. At distant sites, Enrichment addressed the barrier by recruiting individuals who were already coming to the island (for symposia, research, vacation, etc.). Urban community college sites used Enrichment to move the students to events in their region where they could meet scientists (i.e., Enrichment visits to science pubs/nights, conferences, special talks, etc.). However, this approach revealed financial and access barriers, since transportation was often needed to attend. *'Staff time/staff support'* was also referenced in 38% of quotes and described the value of having dedicated staff who could work with students (cited as a barrier when absent). Staff time was critical at the primary site for providing students with writing support for scholarships, graduate/professional applications, and internships, with abstracts and scientific writing cited to a smaller extent. Application anxiety was high, with students typically asking for review and revision support very close to deadlines, requiring dedicated flexible hours from an experienced professional. *"Staff support"* also referred to comments that mentioned Enrichment faculty/staff wanting a way to share materials among sites, or wanting guidance from trained evaluators on how to evaluate student outcomes of Enrichment activities. *'Unmet needs of program students'* was referenced in 29% of barriers quotes. Cited as a barrier when absent, students needed professional writing support to secure scholarships, apply to academic and professional next steps, or submit scientific work. *'Busy student schedules'* was cited as a barrier in 25% of quotes; students are full-time enrolled in biomedical majors, pursuing research, and often must work additional hours at outside jobs or care for family members. Finding consistent times where all students can meet was a common challenge. *'Funding'* was mentioned as a barrier in 17% of quotes, in reference to lacking dedicated staff time or financial support for students to attend conferences/events to network with professionals as part of Enrichment.

<u>Implementation Solutions</u>

Sites offered solutions for implementing Enrichment across 57 quotes (Table 6). Sites described Enrichment as a way to identify and understand student needs at their institutions, often helping students to navigate and advocate for institutional support (e.g., disability and childcare resources, financial aid navigators, culturally competent mental health, financial wellness services, etc.). These solutions offer guidance for institutions wanting to implement programs like Enrichment with their students.

<u>Significant Changes over Study Period</u>

Baseline and follow-up data were coded to understand significant changes that sites made to Enrichment over the 18-month study period. A total of 44 quotes described these changes, with

'Moving beyond research-specific activities to include broader relevant skills' being most prominent. Approximately 57% of quotes described changes to incorporate more professional development skills, and greater emphasis on teaching implicit curriculum around social norms and dynamics of academic and research cultures. Many sites identified that it was valuable to use student input to identify instructional needs and effective curricula. Another major change was *'Interprofessional instructional teams*,' described in 27% of quotes. It referred to needing to replace faculty instructors who had other duties, and developing teaching teams that leveraged instructors across programs and faculty/staff roles, including peer mentors on the teaching team, and leveraging program alumni and graduate students as part of the diverse team. *'Formats and flexible options for students'* was cited as an important change in one quarter of quotes (25%), referring to changes in Enrichment formats (e.g., activities, structures, etc.). The most dramatic change in format occured at the primary site, where students were given more opportunities to attend other cohorts' enrichment sessions, which was reviewed positively by scholars since it allowed them to meet their needs and goals. Other sites also adjusted formats to some extent, responding to meet student needs. *'Increased use of data and evaluation'* to understand student needs occurred over the study period (20%). Sites often used informal evaluation to understand student satisfaction with events, access barriers to instructional supports, or how the term was perceived by students. The primary site's evaluation mirrored course evaluation questions at the university, but also included questions to understand student needs for the coming year. Finally, an *'Increased emphasis on self-care to support research and professional careers'* was represented in 11% of quotes and described additional focus around self-care and mental health, including normalizing those needs, skills to support work-life balance, and how "to identify resources to support them when they need help being successful in research." Student needs and instructional goals can be interwoven to support instructional arcs across program levels (Table 6).

Appendix 7. Additional lessons learned for implementing Enrichment with research trainees.

Student Development

1) Students balancing full-time college, intense life demands, and research training have extreme pressure on their schedules. Requiring their presence brings with it the ethical obligation to make the activity worth their time.
2) What is worth their time is their decision, so instructors need ways to learn and respond to their priorities. All sites created strong feedback loops within Enrichment, using methods from informal conversation to polls and surveys to giving students the authority to create structures they want.
3) While cohort effects can produce strong impacts on student development in the scientific literature, informal and near-peer mentorship are also documented as high-value. 24% of code applications related to cohort and near-peer bonding were "proxy for support." Program participants were coming together through Enrichment, across cohorts, to find solutions for issues that institutions and programs had failed to effectively address.

Program and Institutional Development

1) When program participation is tied to access to education (funding or tuition remission), requiring Enrichment as part of program participation also requires the program create universal access to Enrichment. Doing so requires dedicated work hours.
2) Students underserved and underrepresented in academia and research must be unusually competent to access academia and research. With appropriate support, they often work at a higher level than is typical for undergraduates.

3) Appropriate support requires connecting across the faculty-staff divide. Academic professional staff or faculty-staff teams were key to Enrichment at multiple sites. Academic systems tend to categorize students in an either-or binary: high-needs (served by non-academic staff) or high-performing (served by academic faculty). A healthy future for biomedical research in the United States depends on engaging students who are both. Serving them means creating systems that bring together faculty and support staff. Asking individual underrepresented faculty mentors and staff advisors to substitute in isolation for connected networks is another aspect of "proxy for support." The need is common; it can be addressed if it is not seen as an enormous number of isolated individual problems.
4) Positions for program alumni support effective Enrichment and the careers of program alumni. Relevant biomedical interests include science education, mentorship, social research, and assessment. Research training program graduates are trained research professionals, and best placed to understand program needs and resources at their site. Professionals should be paid.
5) Today's undergraduate is tomorrow's graduate student or junior professional. Models where support is imagined as an institutional cost without benefit, tied to the idea that underrepresentation makes people more needy or less skillful, do not function for professionals who must be recognized as skillful contributors to advance. By making its Scholars supported partners in developing new structures and curricula to meet their own needs, to improve academic and research systems that were not originally built to serve them, Enrichment offers a model for self-defined professional development as institutional development.

Access

All sites showed interest in remote resources and connections to improve access. Several barriers were identified:

1) Where instruction is unstable and institutional course shells expire, materials may not be easily available across years at the same institution.
2) Online learning management systems (e.g., Sakai, Blackboard, Canvas) are easily available at most institutions, but hosting resources can block cross-institutional and alumni access. One instructor at the host site developed a Google Docs folder for a collection of curricular resources and de-identified professional portfolio materials, which was shared with partner sites.
3) Some instructors felt that recording Enrichment would compromise its basic function as a low-risk "safe space" for conversation and practice.
4) Interactive activity is a key feature of Enrichment. Aspects of live interaction are possible online through video conferencing. Web-based activities may support distant sites that report less access to research-related materials and professionals. However, video conferencing was cited only once, by a distant community college.

References

Adams, N. E. (2015). Bloom's taxonomy of cognitive learning objectives. *Journal of the Medical Library Association*, *103*(3), 152–153. https://doi.org/10.3163/1536-5050.103.3.010

Al-Azawei, A., Serenelli, F., & Lundqvist, K. (2016). Universal Design for Learning (UDL): A content analysis of peer reviewed journals from 2012 to 2015. *Journal of the Scholarship of Teaching and Learning*, *16*(3), 39–56. https://doi.org/10.14434/josotl.v16i3.19295

Averill, M. M., Dillon-Sumner, L., Stergachis, A., Sconyers, J., Summerside, N., Brazg, T., & Errett, N. (2019). Integrating public health students into interprofessional education. *Journal of Interprofessional Care*. Advance online publication. https://doi.org/10.1080/13561820.2019.1690436

Barker, K. (1998). *At the Bench, A Laboratory Navigator*. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Bates, C. K., Jagsi, R., Gordon, L. K., Travis, E., Chatterjee, A., Gillis, M., . . . Flotte, T. R. (2018). It is time for zero tolerance for sexual harassment in academic medicine. *Academic Medicine*, *93*(2), 163–165. https://doi.org/10.1097/ACM.0000000000002050

Boekeloo, B. O., Jones, C., Bhagat, K., Siddiqui, J., & Wang, M. Q. (2015). The role of intrinsic motivation in the pursuit of health science-related careers among youth from underrepresented low socioeconomic populations. *Journal of Urban Health*, *92*(5), 980–994. https://doi.org/10.1007/s11524-015-9987-7

Bonham, A., Cohen, J., Florez, J., Gibbons, G., Jenkins, R., Jordan, T., . . . Yancy, C. (2012). *Report of the Advisory Committee to the Director Working Group on Diversity in the Biomedical Research Workforce*. Retrieved from http://acd.od.nih.gov/diversity%20in%20the%20biomedical%20research%20workforce%20report.pdf

Bravata, D. M., Watts, S. A., Keefer, A. L., Madhusudhan, D. K., Taylor, K. T., Clark, D. M., . . . Hagg, H. K. (2020). Prevalence, predictors, and treatment of impostor syndrome: A systematic review. *Journal of General Internal Medicine*, *35*(4), 1252–1275. https://doi.org/10.1007/s11606-019-05364-1

Butler, L. D., Carello, J., & Maguin, E. (2017). Trauma, stress, and self-care in clinical training: Predictors of burnout, decline in health status, secondary traumatic stress symptoms, and compassion satisfaction. *Psychological Trauma: Theory, Research, Practice, and Policy*, *9*(4), 416–424. https://doi.org/10.1037/tra0000187

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups. *Journal of Research in Science Teaching*, *51*(5), 555–580. https://doi.org/10.1002/tea.21146

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues*, *67*, 469–491. https://doi.org/10.1111/j.1540-4560.2011.01710.x

Chen, X. (2013). *STEM attrition: College students' paths into and out of STEM fields* (NCES 2014-001). Retrieved from https://nces.ed.gov/pubs2014/2014001rev.pdf

Clark Blickenstaff, J. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education*, *17*(4), 369–386. https://doi.org/10.1080/09540250500145072

Coe, C., Piggott, C., Davis, A., Hall, M. N., Goodell, K., Joo, P., & South-Paul, J. E. (2020). Leadership pathways in academic family medicine: Focus on underrepresented minorities and women. *Family Medicine*, *52*(2), 104–111. doi:10.22454/FamMed.2020.545847

Cohen, G. L., & Garcia, J. (2008). Identity, belonging, and achievement: A model, interventions, implications. *Current Directions in Psychological Science*, *17*(6), 365–369. https://doi.org/10.1111/j.1467-8721.2008.00607.x

Duffus, W. A., Trawick, C., Moonesinghe, R., Tola, J., Truman, B. I., & Dean, H. D. (2014). Training racial and ethnic minority students for careers in public health sciences. *American Journal of Preventive Medicine*, *47*(5 Suppl 3), S368–375. https://doi.org/10.1016/j.amepre.2014.07.028

Eagan, K., Stolzenberg, E. B., Zimmerman, H. B., Aragon, M. C., Whang Sayson, H., & Rios-Aguilar, C. (2017). *The American freshman: National norms fall 2016*. Los Angeles, CA: Higher Education Research Institute, UCLA.

Estrada, M., Burnett, M., Campbell, A., Campbell, P., Denetclaw, W., Gutiérrez, C., . . . Zavala, M. (2016). Improving underrepresented minority student persistence in STEM. *CBE—Life Sciences Education*, *15*(3), es5. https://doi.org/10.1187/cbe.16-01-0038

Green, J. and N. Thorogood (2014). *Qualitative methods for health research* (3rd ed.). SAGE Publications.

Harris, A. P., & Gonzalez, C. G. (2012). Introduction. In G. G. Muhs, Y. F. Niemann, C. G. Gonzalez, & A. P. Harris (Eds.), *Presumed incompetent: The intersections of race and class for women in academia*. Boulder, CO: The University Press of Colorado.

Harrison, C., & Tanner, K. D. (2018). Language matters: Considering microaggressions in science. *CBE—Life Sciences Education*, *17*(1), 1-8. https://doi.org/10.1187/cbe.18-01-0011

Health Professions Accreditors Collaborative. (2019). *Guidance on developing quality interprofessional education for the health professions*. Chicago, IL: Author.

Hinton, A. O., Termini, C. M., Spencer, E. C., Rutaganira, F. U. N., Chery, D., Roby, R., . . . Palavicino-Maggio, C. B. (2020). Patching the leaks: Revitalizing and reimagining the STEM pipeline. *Cell*, *183*(3), 568–575. https://doi.org/10.1016/j.cell.2020.09.029

Hoppe, T. A., Litovitz, A., Willis, K. A., Meseroll, R. A., Perkins, M. J., Hutchins, B. I., . . . Santangelo, G. M. (2019). Topic choice contributes to the lower rate of NIH awards to African-American/Black scientists. *Science Advances*, *5*(10), eaaw7238. https://doi.org/10.1126/sciadv.aaw7238

Hrabowski, F. A., Ammons, J. H., Clewell, B. C., Grasmick, N. S., Gutierrez, C. G., Hammonds, E. M., . . . Zoback, M. L. (2011). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. Washington, DC: The National Academies Press.

Hussar, B., Zhang, J., Hein, S., Wang, K., Roberts, A., Cui, J., . . . Dilig, R. (2020a). Characteristics of postsecondary students (Figure 1. Percentage distribution of U.S. resident undergraduate enrollment in degree-granting postsecondary institutions, by level and control of institution and student race/ethnicity: Fall 2018). *The Condition of Education 2020* (NCES 2020-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved February 21, 2021 from https://nces.ed.gov/pubs2020/2020144.pdf

Hussar, B., Zhang, J., Hein, S., Wang, K., Roberts, A., Cui, J., . . . Dilig, R. (2020b). Characteristics of postsecondary faculty (Figure 2. For each academic rank, percentage distribution of full-time faculty in degree-granting postsecondary institutions, by race/ethnicity and sex: Fall 2018). *The Condition of Education 2020* (NCES 2020-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved February 21, 2021 from https://nces.ed.gov/pubs2020/2020144.pdf

Ilies, R., Hauserman, N., Schwochau, S., & Stibal, J. (2006). Reported incidence rates of work-related sexual harassment in the United States: Using meta-analysis to explain reported rate disparities. *Personnel Psychology*, *56*(3), 607–631. https://doi.org/10.1111/j.1744-6570.2003.tb00752.x

Jenson, R. J., Petri, A. N., Day, A. D., Truman, K. Z., & Duffy, K. (2011). Perceptions of self-efficacy among STEM students with disabilities. *Journal of Postsecondary Education and Disability*, *24*(4), 269–283.

Kasperiuniene, J., & Zydziunaite, V. (2019). A systemic literature review on professional identity construction in social media. *SAGE Open*, *9*(1). https://doi.org/10.1177/2158244019828847

Keller, T. E., & Lindwall, J. (2020). Investigating a multiple mentor model in research training for undergraduates traditionally underrepresented in biomedical sciences. *Understanding Interventions*, *11*, 12476. https://doi.org/10.1002/sce.20173

Keller, T. E., Logan, K., Lindwall, J., & Beals, C. (2017). Peer mentoring for undergraduates in a research-focused diversity initiative. *Metropolitan Universities*, *28*(3), 50–66. https://doi.org/10.18060/21542

Ladson-Billings, G. (1995). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal*, *32*(3), 465–491.

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education*, *95*(5), 877–907. https://doi.org/10.1002/sce.20441

Marriott, L. K., Coppola, L. A., Mitchell, S. H., Bouwma-Gearhart, J. L., Chen, Z., Shifrer, D., . . . Shannon, J. (2019). Opposing effects of impulsivity and mindset on sources of science self-efficacy and STEM interest in adolescents. *PLoS One*, *14*(8), e0201939. https://doi.org/10.1371/journal.pone.0201939

McFarland, J., et al. (2019a). Undergraduate retention and graduation rates (Figure 1. Percentage of first-time, full-time degree-seeking undergraduate students retained at 4-year degree-granting institutions, by control of institution and acceptance rate: 2016 to 2017). The Condition of Education 2019 (NCES 2019-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved February 21, 2021 from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019144.

McFarland, J., Hussar, B., Zhang, J., Wang, X., Wang, K., Hein, S., . . . Barmer, A. (2019b). Undergraduate retention and graduation rates (Figure 2. Percentage of first-time, full-time degree-seeking undergraduate students retained at 2-year degree-granting institutions, by control of institution: 2016 to 2017). *The Condition of Education 2019* (NCES 2019-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved February 21, 2021 from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019144.

Melnic, A. S., & Botez, N. (2014). Formal, non-formal, and informal interdependence in education. *Economy Transdisciplinary Cognition*, *17*(1), 113–118.

Merolla, D. M., & Serpe, R. T. (2013). STEM enrichment programs and graduate school matriculation: The role of science identity salience. *Social Psychology of Education*, *16*(4), 575–597. https://doi.org/10.1007/s11218-013-9233-7

Moss-Racusin, C. A., Dovidio, J. F., Brescoll, V. L., Graham, M. J., & Handelsman, J. (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences of the United States of America*, *109*(41), 16474–16479. https://doi.org/10.1073/pnas.1211286109

Myers, S. B., Sweeney, A. C., Popick, V., Wesley, K., Bordfeld, A., & Fingerhut, R. (2012). Self-care practices and perceived stress levels among psychology graduate students. *Training and Education in Professional Psychology*, *6*(1), 55–66. https://doi.org/10.1037/a0026534

National Academies of Sciences, Engineering, and Medicine. (2018). *Sexual harassment of women: Climate, culture, and consequences in academic sciences, engineering, and medicine*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24994

National Center for Science and Engineering Statistics. (2018a). *Survey of earned doctorates: Education-related debt (Figure 26. Debt status of doctorate recipients, by debt type and broad field of study: 2018).* Retrieved from https://ncses.nsf.gov/pubs/nsf20301/report/education-related-debt

National Center for Science and Engineering Statistics. (2018b). *Survey of earned doctorates: Education-related debt (Figure 29. Changes in graduate debt, by broad field of study: 2009 and 2018).* Retrieved from https://ncses.nsf.gov/pubs/nsf20301/report/education-related-debt

National Center for Science and Engineering Statistics. (2018c). *Survey of earned doctorates: Education-related debt (Figure 31. Primary source of financial support of doctorate recipients, by 2015 Carnegie classification of institutions: 2018).* Retrieved from https://ncses.nsf.gov/pubs/nsf20301/report/education-related-debt

National Center for Science and Engineering Statistics. (2018d). *Survey of earned doctorates: U.S. doctorate awards—Race and Ethnicity (Figure 6. Doctorates earned by underrepresented minority U.S. citizens and permanent residents: 2009-2018.)*

National Center for Science and Engineering Statistics. (2018e). *Survey of earned doctorates: Education-related debt (Figure 35. Graduate debt of U.S. citizen and permanent resident doctorate recipients, by race, ethnicity, and area of study: 2018).* Retrieved from https://ncses.nsf.gov/pubs/nsf20301/report/education-related-debt

National Institutes of Health. (2009). *Frequently asked questions: Recruitment and retention plan to enhance diversity.* Retrieved from htttps://grants.nih.gov/training/FAQ/diversity.htm#867

National Institutes of Health. (2019). *Notice of NIH's interest in diversity.* Retrieved from https://grants.nih.gov/grants/guide/notice-files/NOT-OD-20-031.html

National Science Foundation. (2017). *Women, minorities, and persons with disabilities in science and engineering.* Retrieved from https://www.nsf.gov/statistics/2017/nsf17310/

Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education: Theory and Practice*, *15*(5), 625–632. https://doi.org/10.1007/s10459-010-9222-y

Richardson, D. M., Keller, T. E., Wolf, D. S. S., Zell, A., Morris, C., & Crespo, C. J. (2017). BUILD EXITO: A multi-level intervention to support diversity in health-focused research. *BMC Proceedings*, *11*(Suppl 12), 19. https://doi.org/10.1186/s12919-017-0080-y

Roulston, A., Montgomery, L., Campbell, A., & Davidson, G. (2018). Exploring the impact of mindfulnesss on mental wellbeing, stress and resilience of undergraduate social work students. *Social Work Education*, *37*(2), 157–172. https://doi.org/10.1080/02615479.2017.1388776

Rubio, D. M., Hamm, M. E., Mayowski, C. A., Nouraie, S. M., Quarshie, A., Seto, T., . . . Norman, M. K. (2019). Developing a training program to diversify the biomedical research workforce. *Academic Medicine*, *94*(8), 1115–1121. https://doi.org/10.1097/ACM.0000000000002654

Scientific Management Review Board. (2015). *Report on pre-college engagement in biomedical science.* Retrieved from https://osp.od.nih.gov/wp-content/uploads/Pre-College-Engagement-in-Biomedical-Science.pdf

Snyder, J., & Cudney, E. A. (2017). Retention models for STEM majors and alignment to community colleges: A review of the literature. *Journal of STEM Education*, *18*(3), 48–57.

Toven-Lindsey, B., Levis-Fitzgerald, M., Barber, P. H., & Hasson, T. (2015). Increasing persistence in undergraduate science majors: A model for institutional support of underrepresented students. *CBE—Life Sciences Education*, *14*(2). https://doi.org/10.1187/cbe.14-05-0082

Trapido-Lurie, B. (Cartographer). (2010a). The Pacific rim (inset). Retrieved from http://geoalliance.asu.edu/maps/regions

Trapido-Lurie, B. (Cartographer). (2010b). United States. Retrieved from http://geoalliance.asu.edu/maps/regions

Trinidad, A. M. (2014). The becoming of a Pinay Scholar Warrior of Aloha: A Critical autoethnography of teaching, mentoring, and researching for social change. *Polymath: An Interdisciplinary Arts and Sciences Journal*, *4*(2), 16–38.

U.S. Census Bureau. (2015). *2014 National population projections tables*. Retrieved from https://www.census.gov/data/tables/2014/demo/popproj/2014-summary-tables.html

U.S. Department of Education. (2019). *Total fall enrollment in degree-granting postsecondary institutions, by control and classification of institution, level of enrollment, and race/ethnicity of student: 2018* (Digest of Education Statistics). Retrieved from https://nces.ed.gov/programs/digest/d19/tables/dt19_306.50.asp

Usher, E. L., & Parajes, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of Educational Research*, *78*(4), 751–796. https://doi.org/10.3102/0034654308321456

Valantine, H. A., & Collins, F. S. (2015). National Institutes of Health addresses the science of diversity. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(40), 12240–12242. https://doi.org/10.1073/pnas.1515612112

Valantine, H. A., Lund, P. K., & Gammie, A. E. (2016). From the NIH: A systems approach to increasing the diversity of the biomedical research workforce. *CBE–Life Sciences Education*, *15*(3). https://doi.org/10.1187/cbe.16-03-0138

Yasunaga, M. (2014). *Non-formal education as a means to meet learning needs of out-of-school children and adolescents*. Retrieved from UNESCO Institute for Statistics: http://ais.volumesquared.com/wp-content/uploads/2015/01/OOSC-2014-Non-formal-education-for-OOSC-final.pdf

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 287-300.
doi: 10.14434/josotl.v21i1.30462

Can Undergraduate Research Participation Reduce the Equity Gap?

Prajukti Bhattacharyya
University of Wisconsin-Whitewater
bhattacj@uww.edu

Catherine W.M. Chan[1]
University of Wisconsin-Eau Claire
chancw@uwec.edu

Abstract: Undergraduate research (UGR), one of several high-impact practices (HIPs) in education, can positively impact student retention and graduation rates. However, not all students take advantage of UGR opportunities, with fewer students from underrepresented minority groups, those with first-generation status, and students eligible for a Pell grant or federally subsidized loan. We obtained retention and graduation data from our Office of Institutional Research and Planning for all UGR participants for academic years 2009–2010 to 2016–2017. We specifically focused on data for UGR participants from underrepresented demographics that historically have lower retention and graduation rates than those of the overall student body. We created Sankey-like ribbon diagrams to analyze the characteristics of UGR participants, whether they participated in UGR for 1 year or longer, their class standings when they started UGR, retention rates for 1st- and 2nd-year students for the year following their UGR participation, and graduation rates for all participants. Our data show that irrespective of demographics, students who participated in UGR were significantly more likely to persist in college and graduate within 6 years compared to students who did not. Persistence and success in college may depend on students' socioeconomic status, sense of belonging, and other factors. Assessing the impact of a single HIP, such as UGR, on retention and graduation rates, can, therefore, be complicated. However, our study indicates that UGR participation can significantly improve persistence and success for students traditionally considered "at-risk," irrespective of their socioeconomic status, family background, or class standing.. This information can be important for campus leaders and other stakeholders interested in facilitating student success and reducing the equity gap by incorporating UGR in more students' college experiences. We describe our analytical methods and discusses our findings. We also demonstrate the effectiveness of Sankey-like diagrams for visualizing and analyzing large programmatic data sets, and as a tool for communicating program impacts to a general audience.

Keywords: undergraduate research, high-impact practice, student success, equity gap, ribbon tool

Introduction

Undergraduate Research as a High-Impact Practice

Kuh (2008) identified 10 (later modified to 11, Kuh, O'Donnell, & Schneider, 2017, Figure 1) high-impact practices (HIPs) in education that can promote student engagement, academic achievement, persistence, satisfaction, and attainment of desired academic outcomes. The effects of HIPs have been shown to be more pronounced on students from underserved backgrounds (e.g., Kuh, O'Donnell, &

[1] Previously with the University of Wisconsin-Whitewater.

Schneider, 2017), such as those who are from historically underrepresented racial or ethnic groups, are first in their family to attend college, or are less prepared academically.

Undergraduate research (UGR), where students work closely with mentors outside the classroom to address various research questions, is one of the HIPs. This experience allows students to engage in addressing contested questions and in creating new knowledge through inquiry under the mentorship of practitioners. Besides academic benefits while in college, UGR can also provide long-term benefits after graduation. For example, the results from a recent Gallup survey (Ray & Kafka, 2014) demonstrate that students who participated in experiential learning activities and who felt emotionally supported by at least one mentor in college were much more likely to be engaged at work and achieve a higher quality of life. Similarly, Griswold (2019) showed the impact of UGR experience on identifying future career paths for students after graduation. However, despite such documented direct and indirect benefits, students from underserved backgrounds often do not participate in extracurricular HIPs, such as UGR (e.g., Finley & McNair, 2013; Kuh et al., 2017). The reasons for this include but are not limited to lack of time, family and/or financial constraints, or a lack of awareness of available mentored research opportunities or the benefits thereof.

The type and manner of UGR also vary from campus to campus. Johnson and Stage (2018) defined UGR as a HIP in which upper-level undergraduate students help faculty with their research agendas, or where the institution provides independent research opportunities for undergraduate students. The duration and requirements for participation in UGR can also vary. The duration can range from 5- to 10-week summer research programs or off-campus REU (research experience for undergraduates) programs to one or two academic terms (semesters, trimesters, or quarters) for a senior thesis or capstone project on campus. Participation in most REU programs involves obtaining recommendation letters from faculty and requires an above-average grade point average (GPA). These requirements can often disproportionately exclude students from traditionally underserved backgrounds from participating in UGR. For example, returning adult students, first-generation students, and transfer students, who may not have found a connection with faculty/staff members or who may not feel comfortable approaching faculty outside of classrooms, often end up not obtaining letters of recommendation from faculty. GPA requirements may exclude students with poor academic preparation and/or those who need extra time adjusting to the demands of college, as well as those who can devote less time to coursework than the traditional student population because of health issues and/or work and family obligations. Therefore, although institutions provide UGR opportunities, these opportunities may not always be equitable.

How We Managed to Increase UGR Participation From Underserved Groups at the University of Wisconsin–Whitewater

This project was conducted at the University of Wisconsin–Whitewater (UW-W), a 4-year regional comprehensive university that merged with a 2-year branch campus during the 2018–2019 academic year. We have established two parallel programs administered by the UW-W Undergraduate Research Program (URP). The traditional URP offerings are based on the philosophy that UGR experiences are most suitable for those students who have already demonstrated the disciplinary background, academic standing, and habits necessary for success in college. Students participating in the traditional URP are most often in their 3rd or 4th year in college, have a cumulative GPA of 2.75 or higher, and have already identified mentors to guide their research projects in their chosen disciplines. In contrast, our Research Apprenticeship Program (RAP) piloted in the 2011–2012 academic year, focuses on beginning and transfer students and also allows for international student participation. RAP recruits these students as paid research assistants for interested faculty mentors, without considering their GPA, research experience, or academic background.

Participants in the traditional URP are expected to develop their research proposals themselves with help and guidance from their mentors, as opposed to mostly acting as research assistants for their mentors. These participants can apply for research credits to count toward their academic degree program but are not paid for their work unless it is done during the summer months. They are also expected to present their research to a general audience on campus and at appropriate off-campus venues. In contrast, RAP participants are not expected to develop their own research projects but are paid to assist with the research agenda of their mentors. They are encouraged to present their work but are not required to do so. Both traditional URP and RAP students are expected to participate in research for two academic semesters after being accepted in the chosen program.

The framework for our campus URP, therefore, allows us to offer several key HIPs, by giving students the opportunity to engage in exploring contested questions outside the classroom, participate in one-on-one mentorship, receive frequent constructive feedback, and publicly demonstrate their competence. The differences in the characteristics of students participating in the traditional URP and RAP are summarized in Table 1.

Table 1. Characteristics of participants in the traditional Undergraduate Research Program (URP), the Research Apprenticeship Program (RAP), and the overall student body.

Characteristic	Traditional URP participants (%; *N* = 621)	RAP participants (%; *N* = 338)	Overall student body weighted average (%; *N* = 65,325)
White/Caucasian	88	65	84.34
African-American/Black	2	8	4.46
Hispanic/Latino or Latina	4	12	4.74
Two or more races	2	7	1.89
International	2	3	1.09
Southeast Asian	1	3	0.80
Other Asian	1	2	0.82
Under 24 years old at entry	91	96	97.88
First-generation status	31	44	40.72
Pell grant recipient	26	29	18.68
Federally subsidized loan recipient	24	19	No data
Joined as 1st-year student	3.16	53.98	
Joined as sophomore	15.78	36.93	
Joined as junior	33.72	5.97	
Joined as senior	47.35	3.13	

Note. All weighted averages 2011–2017 except for under 24 years old at entry (weighted average 2014–2019).

A member of an underrepresented minority (URM) is defined on campus as a student who indicates a race/ethnicity of African American/Black, American Indian, Hispanic/Latino or Latina, or Southeast Asian, either alone or in combination with other races/ethnicities. Table 1 shows that the RAP has been more successful than the traditional URP in recruiting an ethnically diverse student population, with students from all URM groups being overrepresented, and also in engaging students in research early in their college career. Besides students from URM groups, a significant proportion (almost 41%) of the UW-W student body also identified as a first-generation student (defined as an undergraduate student whose parents have not earned a 4-year college/university degree), and/or qualified for a Pell grant (almost 19%) or some form of federally subsidized loan; indicators of financial need. Both the traditional URP and the RAP have been successful in recruiting students from these underserved demographics as well. Finally, the mean cumulative ACT scores for traditional URP participants (23.86) and RAP participants (23.41) are comparable to the overall average cumulative ACT score (22.2) for incoming 1st-year students on campus.

Research Question

Historically on our campus, students belonging to URM groups, first-generation students, and those eligible for a Pell grant or federally subsidized loan have shown lower retention and 6-year graduation rates than those of the overall student body. For this article, we wanted to address the following research question: *Can the retention and 6-year graduation rates for students from underserved demographics be impacted by participating in the traditional URP and/or RAP on campus?*

To address this question, we used data collected by the UW-W Office of Institutional Research and Planning for traditional URP participants spanning the academic years 2007–2008 to 2016–2017, and for RAP participants from 2010–2011 to 2016–2017. The authors were administrators of the traditional URP and the RAP for the entirety of this period and had a direct role in acquiring the data and ensuring that the data set was robust, reviewed, and internally consistent. Our data include student demographic information (URM status, first-generation status, and whether participants were eligible for a Pell grant or federally subsidized loan) for all participants, 2nd- and 3rd-year retention data for all RAP participants, and 6-year graduation rates for all traditional URP participants.

We broke down our overall research question into the following constituent parts for detailed analyses:

1. At what stage(s) of their college career do students from different demographics enroll in the traditional URP and/or RAP?
2. How do the 6-year graduation rates for students from underserved groups participating in UGR compare to the 6-year graduation rates for students from those specific groups in the overall student body?
3. How do the 6-year graduation rates for all students participating in UGR for 1 year and 2- or more years compare with the 6-year graduation rate for the overall student body?
4. What is the retention rate for students from different demographics after completing a year of UGR in their 1st or 2nd year of college compared to the 2nd- and 3rd-year retention rate for students from those demographics in the overall student body?

Method

Traditionally, Sankey diagrams are used in disciplines such as engineering and supply chain management, among others, to visualize energy and/or material flows (Sankey, 1898; Schmidt, 2008a, 2008b). In these diagrams, the thickness of the flows indicates the relative proportions of the material flowing between categories. For this project, we used our URP/RAP participant data set to create Sankey-like diagrams using the online Ribbon tool developed by researchers at the University of California, Davis (2018; Molinaro, Steinwachs, Li, & Guzman-Alvarez, 2017). This tool has been used to visualize how students select or leave academic majors throughout their college career (e.g., Bradforth et al., 2015). We used these diagrams to visualize and analyze URP/RAP participation trends for different student populations during their college career (Figure 1).

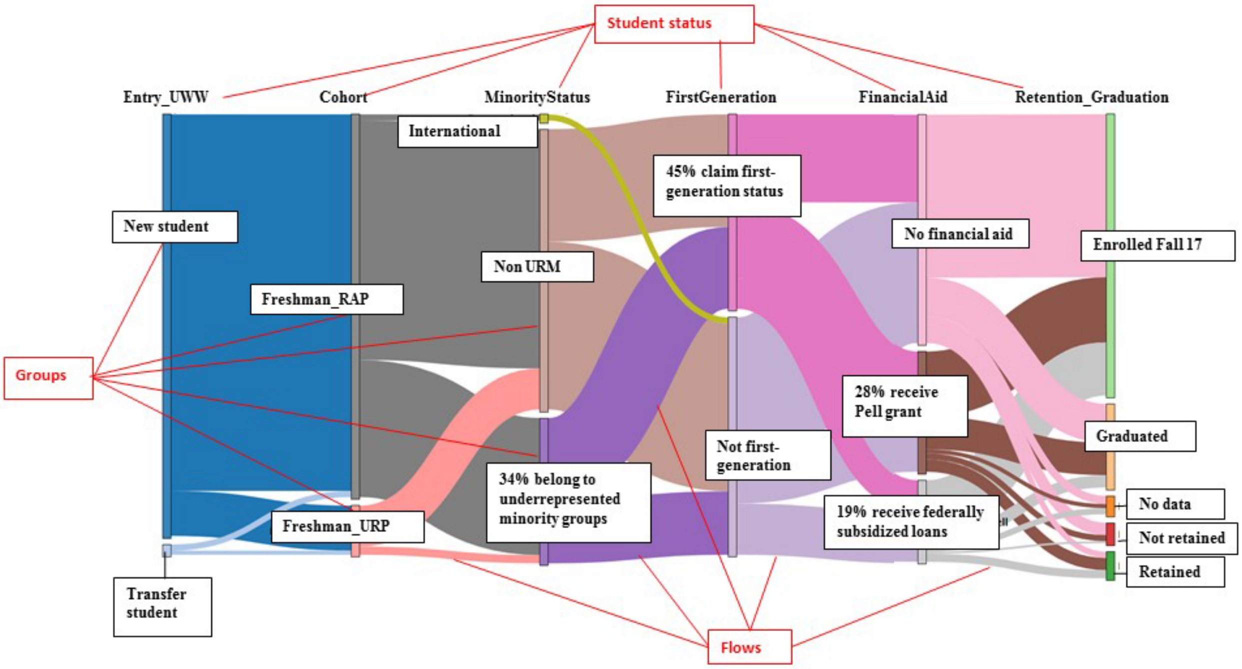

Figure 1. Example of a visualization diagram created using the Ribbon tool. The diagram displays data for students who joined the traditional Undergraduate Research Program (URP) or the Research Apprenticeship Program (RAP) at the University of Wisconsin–Whitewater (UWW) within their 1st year of study; data collected 2011–2017 (*N* = 222).

The two most important aspects of these types of diagrams are the segmented columns, labeled "student status" in Figure 1 but referred to as "time steps" by the creators of the Ribbon tool (Molinaro et al., 2017; University of California, Davis, 2018), and the "flows" joining different segments of those columns. The width of the flows is proportional to the number of elements (in this case, number of student participants) in the flow. Conventionally, the time steps represent academic years or semesters spanning the data set. However, for our project the time steps represented different pieces of student information, such as financial aid status, first-generation status, and class standing at the time students started participating in UGR, among others. The segments of each column are called "nodes" in traditional Sankey diagrams. On Ribbon diagrams they are referred to as "groups." Groups or nodes are zones where the flows originate, end, converge, or diverge. There has to be a minimum of two groups at either end of a Ribbon diagram. The width of a group is proportional to the number of students in that group.

The web-based Ribbon tool allows users to obtain the number of students in each group and the relative percentages of different student groups distributed across the studied population. This capacity allowed us to analyze and synthesize our data set and conveniently extract relevant information for different student demographics participating in UGR for this project. Examples of information obtained from the Ribbon tool are shown as text boxes on the Ribbon diagram (Figure 1).

We reformatted and reorganized the URP/RAP participant data set obtained from the UW-W Office of Institutional Research and Planning to be compatible with the Ribbon tool. For our analyses, each participant was identified by a unique computer-generated seven-digit identification number (CID). We defined the student status and related groups corresponding to each CID as shown in Table 2.

Table 2. Student status codes in the Ribbon tool and corresponding groups within them as used in our analyses.

Student status code	Student status subgroup
Entry_UWW (Status when enrolling in UW-W)	New student
	Transfer student
Cohort (Class standing when joining either the URP or the RAP for the first time)	RAP_1st yr
	RAP_2nd yr
	URP_1st yr
	URP_2nd yr
	URP_junior
	URP_senior
MinorityStatus (Whether student belongs to a URM group or is an international student)	International
	Non_URM
	URM
FirstGeneration	1st Gen
	Not 1st Gen
FinancialAid (Whether eligible for a Pell grant or federally subsidized loan)	Pell
	Federally subsidized loans
	No financial aid
UR participation	One year
	2 or more years
CurrentStatus (Current academic status, including whether students were retained for 1 year past their UGR experience)	Enrolled in Fall 17
	Graduated
	Retained
	Not retained
	No Data (includes students who transferred to another campus)

Note. Gen = Generation; RAP = Research Apprenticeship Program; UR = undergraduate research; URP = Undergraduate Research Program; UWW and UW-W = University of Wisconsin-Whitewater; yr = year.

Results

In this section we briefly describe the information we gathered from the Ribbon tool regarding the overall patterns of UGR experiences for the following student demographics: (a) transfer students, (b) first-generation students, (c) students belonging to a URM group, (d) students receiving a Pell grant, and (e) students receiving a federally subsidized loan. Students belonging to these groups are traditionally considered "academically at-risk," and we focused our analyses on exploring how participating in the traditional URP or RAP might affect academic success for them. We used data for all students (*N* = 1,049) who participated in UGR during 2011–2017 (in either the traditional URP or RAP) unless otherwise specified. We have broken down the results according to the different constituent parts of our research question, listed above.

At what stage(s) of their college career do students from different demographics enroll in the traditional URP and/or RAP?

a) **Transfer students**: Transfer students made up 23% (*n* = 239) of all students participating in UGR used for this analysis. Of these, 82% (*n* = 197) joined the traditional URP, most as seniors (45%, *n* = 108), juniors (28%, *n* = 66), and sophomores (9%, *n* = 21). The rest (18%, *n* = 42) participated in the RAP, primarily as sophomores (9%, *n* = 22). Eighty-three percent of transfer students (*n* = 199) participated in UGR for 1 year, while 17% (*n* = 40) participated for 2 or more years.
b) **First-generation students**: First-generation students made up 35% (*n* = 369) of all UGR participants in this analysis. Of these, 43% (*n* = 157) participated in the RAP, 22% (*n* = 83) in their freshman year and 15% (*N* = 55) during their sophomore year. Twenty-five percent (*n* = 92) joined the traditional URP as seniors and 19% (*n* = 71) as juniors. Eight-four percent (*n* = 310) of first-generation students participated in UGR for 1 year, while 16% (*n* = 59) participated for 2 or more years.
c) **Students belonging to a URM group**: Students belonging to a URM group made up 17% of UGR participants used for this analysis (*n* = 171). Of these, 64% (*n* = 108) joined the RAP, 40% (*n* = 68) in their first year and 16% (*n* = 28) in their sophomore year; 12% (*n* = 21) joined the traditional URP in their junior year and 20% (*n* = 34) in their senior year. Eighty-seven percent (*n* = 149) of participants belonging to a URM group participated in UGR for 1 year, while 13% (*n* = 22) participated for 2 or more years.
d) **Students receiving a Pell grant**: Students receiving a Pell grant made up 27% of UGR participants used for this analysis (*n* = 286). Of these, 63% (*n* = 183) joined the traditional URP, the majority as seniors (34%, *n* = 97) and juniors (21%, *n* = 61). The rest (36%, *n* = 103) joined the RAP, mostly as 1st-years (18%, *n* = 52) and sophomores (15%, *n* = 43). Eighty-four percent (*n* = 241) of Pell recipients participated in UGR for 1 year, while 16% (*n* = 45) participated for 2 or more years.
e) **Students receiving a federally subsidized loan**: Students receiving a federally subsidized loan made up 22% of UGR participants used for this analysis (*n* = 233). Of these, 73% (*n* = 171) joined the traditional URP, the majority as seniors (31%, *n* = 72), juniors (23%, *n* = 53), and sophomores (16%, *n* = 38). The rest (27%, *n* = 62) joined the RAP, mostly in their first (13%, *n* = 31) or sophomore (9%, *n* = 22) year. Eighty-one percent (*n* = 188) of students receiving a federally subsidized loan participated in UGR for 1 year, while 19% (*n* = 45) participated for 2 or more years.

How do the 6-year graduation rates for students from underserved groups participating in UGR compare to the 6-year graduation rates for students from those specific groups in the overall student body? How do the 6-year graduation rates for all students participating in UGR for 1 year and 2 or more years compare with the 6-year graduation rate for the overall student body?

We calculated the 6-year graduation rates for UGR participants broken down for different student demographics using the Ribbon tool. For a comparison we calculated 5-year weighted averages of 6-year graduation data for corresponding student demographics spanning academic years 2006–2007 to 2010–2011 for the overall student body using data provided by the UW-W Office of Institutional Research and Planning. We conducted the same analyses on 6-year graduation rates for all first-time students, full-time students, and those with 1 year and 2 or more years of UGR experience, irrespective of their demographics or socioeconomic status, and compared these with the 5-year weighted average of the 6-year graduation rate for the overall student body.

We conducted chi-square and Fisher's exact tests to see if students participating in UGR were statistically significantly more likely to graduate from college within 6 years than their peers not participating in UGR. The Fisher's exact test is more conservative than the chi-square test, and any significant difference between groups can be considered meaningful. The results are shown in Table 3. The 6-year graduation rates of students participating in UGR were statistically significantly higher than those of corresponding student populations in the overall student body.

Table 3. Statistical analyses of 6-year graduation rates of students participating in UGR and graduation rates for corresponding student populations in the overall student body, academic years 2006–2007 to 2010–2011.

Student status category	χ^2	Fisher's exact test	6-year graduation rate		p
			UGR participants	Overall student body	
Transfer students (N = 206)	39.669	< .00001	89%	67.87%	< .00001
First-generation students (N = 250)	52.505	< .00001	80%	56.42%	< .00001
Members of URM groups (N = 101)	19.445	0	63%	40.75%	< .00001
Pell grant recipients (N = 219)	85.311	< .00001	81%	48.24%	< .00001
Federally subsidized loan recipients (N = 167)	51.202	< .00001	87%	58.83%	< .00001
Students with 1 year of UGR experience (N = 618)	164.94	< .00001	84%	58.2%	< 0.00001
Students with 2 or more years of UGR experience (N = 135)	54.238	< .00001	90%	58.2%	< .00001

Student status category	χ^2	Fisher's exact test	6-year graduation rate		p
			UGR participants	Overall student body	
First-time, full-time students (N = 547)	142.37	< .00001	84%	58.2%	< .00001

Note. UGR = Undergraduate research; URM = underrepresented minority. All p values significant at $p < .05$.

What is the retention rate for students from different demographics after completing 1 year of UGR in their 1st or 2nd year of college compared to the 2nd- and 3rd-year retention rates for students from those demographics in the overall student body?

The 2nd- and 3rd-year retention rates for students from the specified demographics are provided in Tables 4 and 5, respectively. The 2nd-year retention rates (Table 4) were calculated on 176 students (152 students participating in the RAP and 24 in the traditional URP) who joined the traditional URP or RAP as 1st-year students. Statistical analyses show that the 2nd-year retention rate of students participating in UGR was statistically significantly higher at the 95% confidence level than that of students from the same demographics in the overall student body, except for students receiving a federally subsidized loan. The 3rd-year retention rates (Table 5) were calculated on 239 students (135 students participating in the RAP and 104 in the traditional URP) during their sophomore year. Statistical analyses show that the 3rd-year retention rate of students participating in UGR was statistically significantly higher than that of students from the same demographics in the overall student body. These numbers exclude students who joined the program during the 2016–2017 academic year. Since very few transfer students joined the traditional URP or RAP as first-years and sophomores, Tables 4 and 5 do not include separate retention rates for transfer students. Instead, we compared 2nd-year retention data for all first-time, full-time students and 3rd-year retention data for all sophomores participating in UGR to the corresponding overall student body retention rates (5-year weighted average). Retention data for specific student demographics from the overall student body were obtained from the UW-W Office of Institutional Research and Planning.

We conducted chi-square and Fisher's exact tests to determine if students participating in the traditional URP or RAP during their 1st or 2nd year of college were statistically significantly more likely to be retained in the academic year following their UGR participation. These results for 1st- and 2nd-year students are also shown in Tables 4 and 5, respectively.

Table 4. Second-year retention rates of students participating in UGR versus the overall student body for selected demographics.

Student category	2nd-year retention rate		χ^2	Fisher's exact test	p
	UGR participants	Overall student body			
First-generation students (N = 80)	94.94%	77.7%	11.7989	.0002	.000593[a]
Students belonging to	89.47%	73.27%	5.0865	.0233	.024113[a]

Student category	2nd-year retention rate		χ^2	Fisher's exact test	p
	UGR participants	Overall student body			
URM groups (N = 59)					
Pell grant recipients (N = 59)	94.74%	76.79%	7.112	.007	.007657 [a]
Federally subsidized loan recipients (N = 39)	97.30%	81.15%	3.1479	.0955	.076025 [b]
All 1st-year students in traditional URP/RAP (N = 176)	94.05%	80.05%	10.3165	.0008	.001318 [a]

Note. RAP = Research Apprenticeship Program; UGR = undergraduate research; URM = underrepresented minority; URP = Undergraduate Research Program.
[a] Significant at $p < .05$. [b] $0.1 > p > 0.05$.

Table 5. Third-year retention rates retention rates of students participating in UGR versus the overall student body for selected demographics.

Student category	3rd-year retention rate		χ^2	Fisher's exact test	p
	UGR participants	Overall student body			
First-generation students (N = 96)	93.55%	66.92%	24.0267	< .00001	< 0.00001
Students belonging to URM groups (N = 36)	90.63%	60.73%	5.8228	.0153	.015819
Pell grant recipients (N = 65)	93.55%	64.95%	16.6083	0	.000046
Federally subsidized loan recipients (N = 57)	98.08%	71.5%	8.905	.0016	.002844
All 2nd-year students in traditional	94.03%	70.05%	44.5297	< .00001	< 0.00001

Student category	3rd-year retention rate		χ^2	Fisher's exact test	p
	UGR participants	Overall student body			
URP/RAP (N = 239)					

Note. RAP = Research Apprenticeship Program; UGR = undergraduate research; URM = underrepresented minority; URP = Undergraduate Research Program. All p values significant at $p < .05$.

Discussion

Mentored UGR is well integrated in our campus culture. UGR participants can engage in mentored research for one or more years as an extra- or cocurricular activity. They receive one-on-one mentoring, opportunity to design and take ownership of their own projects (mostly traditional URP participants), or help faculty mentors or upper-level students with their research (RAP participants). Traditional URP participants are also expected to present their research on campus during spring and/or fall Undergraduate Research Days and off campus at the National Conference on Undergraduate Research or statewide symposia for scholarly and creative activities. While a presentation is not expected of RAP participants, they are strongly encouraged to participate during on-campus UGR celebration events. UGR participants also have the opportunity to apply to the UW-W Summer Undergraduate Research Fellowship program, a highly competitive 10-week summer research program.

Being engaged in research has various tangible and intangible benefits for students. They learn to effectively communicate orally and in writing, analyze and synthesize their data to make valid conclusions, critically evaluate concepts from different perspectives, and other valuable skills. A survey by Hart Research Associates (2015) found that employers strongly endorsed an emphasis on applied learning in college and believed that working on applied learning projects would prepare students better for a career after graduation and improve their chances of being hired. Student researchers also learn how to work as part of a team, be respectful of others, receive constructive criticism, and deal with setbacks. Being part of a group/research team, hands-on experience, and being engaged in solving a real-world problem are among the benefits of mentored research, all of which can increase students' sense of belonging and provide a support network for them to persist in college (e.g., Strayhorn, 2019).

Both traditional URP and RAP students work closely with faculty and staff mentors and in many cases, also have upper-level students acting as near-peer mentors. We surveyed RAP students (Institutional Review Board Protocol Number: B14509018Q) in academic years 2014–2015 and 2016–2017 at the beginning of their research experience, after one semester of conducting research, and again at the end of their one academic year of RAP experience to gauge the progressive change in their self-perceptions of skills and knowledge gain (Bhattacharyya, Chan, & Waraczynski, 2018). We also gathered information on what beginning students identified as benefits of research besides learning to do research. Our results show that 28.1% of responders (68 participants over three cohorts) identified "network and support" from faculty and staff mentors and peers as one of the major benefits of conducting mentored research.

Positive impacts of mentoring on undergraduate STEM students, especially on those from minority backgrounds have been documented (e.g., Haeger & Fresquez, 2016). Students from traditionally underrepresented groups in STEM fields who participated in mentored UGR showed significantly higher cumulative GPAs and similar graduation rates to those of matched peers. Furthermore, students participating in UGR for an extended period of time (longer than one academic semester or one summer) showed significantly higher gains in research skills and level of research independence.

Our data show that students participating in UGR as part of either the traditional URP or the RAP were statistically significantly more likely at a 95% confidence level to be retained during the academic year immediately following their UGR experience, as well as graduate from college within 6 years, irrespective of their background or socioeconomic status, including students traditionally considered academically at-risk. On our campus, considerable equity gaps remain in retention and graduation rates between students from underserved demographics and majority students. UGR participation can potentially be a way to reduce this gap. This is especially relevant given the changing student demographics at UW-W. Figure 2 shows changes in the URM student population at UW-W over the last 10 years (2009–2019). The data show an increase in the overall URM population from 9.2% in the 2009–2010 academic year to 14.5% in 2018–2019. Over the same time span, our Hispanic/Latino or Latina student population has increased from 2.7% to 7.40% of the overall student population. Increasing UGR participation for these students can be a way to help all students succeed.

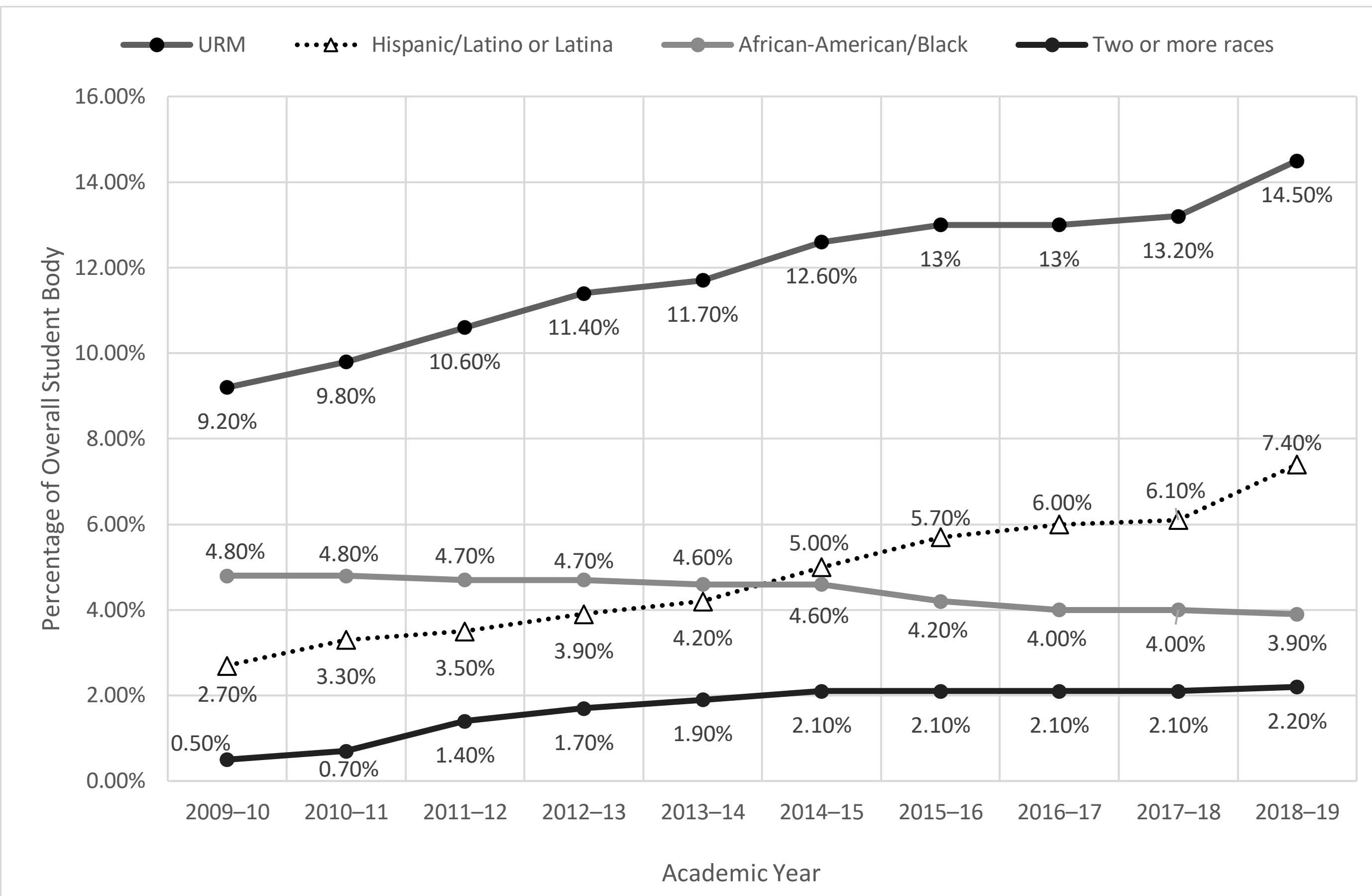

Figure 2. Changes in percentage of underrepresented minority (URM) student groups on campus from 2009–2010 to 2018–2019.

We should not, however, assume that UGR participation is the sole driver of student success. Students who self-select to participate in UGR are also more likely to participate in other HIPs, such as internships. Most traditional URP participants joined in their junior or senior year (Table 1), and therefore, they had already successfully navigated their way through their first 2 years of college when students are most at risk of dropping out. They also met the minimum GPA requirement for the traditional URP, indicating that they were academically in good standing and therefore more likely to graduate within 6 years. Traditional URP students were also more likely to have made a connection with a faculty mentor in their chosen discipline and to have developed an identity as a scholar and researcher.

In contrast, RAP recruits beginning students who have not yet made a connection to campus or their discipline and pairs them with research mentors as paid research assistants to help faculty with their research agenda. While the data on student retention (Tables 4 and 5) demonstrate the impact of UGR participation on 2nd- and 3rd-year retention of beginning students, especially those traditionally considered to be academically at-risk, the RAP program is still relatively new, and we do not yet have the data to measure its sustained impact on student retention and graduation rates. Also, for logistical reasons, only a limited number of students can participate in RAP in any given semester, and therefore, more work still needs to be done to broaden UGR participation for beginning students.

Nonetheless, our data on the positive effects of UGR participation on students' academic outcomes, even if incomplete, are promising. Currently, many colleges and universities are working on strategies to boost retention and graduation rates of their students as part of their moral obligation as institutions of higher education. This undertaking also has financial consequences for public institutions in states with performance-based funding models, whereby allocation of state funding to public colleges and universities is at least partially dependent on student outcomes. UGR participation can be implemented as part of a comprehensive student success program to increase student persistence and degree completion rates, especially for those from underserved backgrounds. Broadening UGR participation obviously requires resources but it can also be considered an investment in improving student outcomes that can also yield financial returns.

Conclusion

Our data show that mentored UGR conducted over one or more academic years, where students are allowed to design and conduct their own research projects with help and guidance from faculty/staff mentors, can positively impact persistence and 6-year graduation rates for students, especially for those from demographics traditionally considered academically at-risk. Beginning students helping mentors with their research agendas are also significantly more likely to persist in college than their counterparts not participating in research. While UGR cannot be identified as the sole factor driving student persistence and success, it can provide essential tangible academic skills and intangible benefits, such as a sense of belonging to the discipline and the university, a support network of fellow researchers, one-on-one mentoring from faculty/staff, and the self-efficacy necessary for academic success, and ultimately it can reduce the equity gap.

Acknowledgments

The authors would like to thank the Provost's Office at the University of Wisconsin-Whitewater for providing financial support to the URP and RAP. The pilot phase of the RAP was supported by a campus Strategic Initiatives Grant. We also thank all UW-W Undergraduate Research Program staff and staff/faculty mentors who help make undergraduate research a HIP, and the Office of Institutional Research and Planning for providing campus-level student demographic data. Finally, we appreciate the thoughtful feedback from an anonymous peer reviewer.

References

Bhattacharyya, P., Chan, C. W. M., & Waraczynski, M. (2018). How novice researchers see themselves grow. *International Journal for the Scholarship of Teaching and Learning*, *12*(2), Article 3. https://doi.org/10.20429/ijsotl.2018.120203

Bradforth, S. E., Miller, E. R., Dichtel, W. R., Leibovich, A.K., Feig, A.L., Martin, J.D., ... Smith, T. L (2015). University learning: Improve undergraduate science education. *Nature*, *523*, 282–284. https://doi.org/10.1038/523282a

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

Griswold, W. (2019). Launching sustainability leadership: Long-term impacts on educational and career paths in undergraduate research experiences. *Journal of College Science Teaching*, *49*, 19–23. https://doi.org/10.2505/4/jcst19_049_01_19

Haeger, H., & Fresquez, C. (2016). Mentoring for inclusion: The impact of mentoring on undergraduate researchers in the sciences. *CBE—Life Sciences Education*, *15*(3), 1–9. https://doi.org/10.1187/cbe.16-01-0016

Hart Research Associates. (2015). *Falling short? College learning and career success*. Washington, DC: Association of American Colleges and Universities. Retrieved from https://www.aacu.org/public-opinion-research

Johnson, S. R., & Stage, F. K. (2018). Academic engagement and student success: Do high-impact practices mean higher graduation rates? *The Journal of Higher Education*, *89*, 753–781. https://doi.org/10.1080/00221546.2018.1441107

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., O'Donnell, K., & Schneider, C. G. (2017). HIPs at ten. *Change: The Magazine of Higher Learning*, *49*(5), 8–16. https://doi.org/10.1080/00091383.2017.1366805

Molinaro, M., Steinwachs, M., Li, Q., & Guzman-Alvarez, A. (2017). Promoting instructor and department action via simple, actionable tools and analyses. In J. Greer, M. Molinaro, X. Ochoa, & T. McKay (Eds.), *Proceedings of the 1st Learning Analytics for Curriculum and Program Quality Improvement Workshop* (PCLA 2016), 25 April 2016, Edinburgh, Scotland (pp. 34–38). Retrieved from http://ceur-ws.org/Vol-1590/paper-07.pdf

Ray, J., & Kafka, S. (2014). *Life in college matters for life after college*. Retrieved from http://www.gallup.com/poll/168848/life-college-matters-life-college.aspx

Sankey, H. R. (1898). Introductory note on the thermal efficiency of steam-engines. Report of the committee appointed on the 31st March, 1896, to consider and report to the council upon the subject of the definition of a standard or standards of thermal efficiency for steam-engines: With an introductory note. *Minutes of Proceedings of the Institution of Civil Engineers*, *134*, 278–283.

Schmidt, M. (2008a). The Sankey diagram in energy and material flow management, Part I: History. *Journal of Industrial Ecology*, *12*, 82–94. https://doi.org/10.1111/j.1530-9290.2008.00004.x

Schmidt, M. (2008b). The Sankey diagram in energy and material flow management Part II: Methodology and current applications. *Journal of Industrial Ecology*, *12*, 173–185. https://doi.org/10.1111/j.1530-9290.2008.00015.x

Strayhorn, T. L. (2019). *College students' sense of belonging: A key to educational success for all students*. New York, NY: Routledge, Taylor & Francis.

University of California, Davis. (2018). *Ribbon tool*. Retrieved from https://cee.ucdavis.edu/tools

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 301-319.
doi: 10.14434/josotl.v21i1.30648

Undergraduate Research as a System: Mapping the Institutional Landscape of a High-Impact Practice

Laura E. Cruz
Pennsylvania State University

Devon Anckle
Pennsylvania State University

Lara LaDage
Pennsylvania State University

Amy Chan Hilton
University of Southern Indiana

Alan Rieck
Pennsylvania State University

Abstract: This study examines the written and visual results of a participatory systems-mapping process used to explore undergraduate research at a large, public research university in the United States. With the university's transition to a high-impact practice model, the institutional value of undergraduate research has increased, but challenges remain in implementing the practice equitably and inclusively, especially in the complex environment of higher education. The systems-mapping process reveals the subtle, often conflicting dynamics that underlie the undergraduate research enterprise, while simultaneously supporting the emergence of a shared vision, or story, of what the undergraduate research experience could be.

Keywords: high-impact practice (HIP), undergraduate research, systems thinking, systems mapping, research universities, organizational change

The blind men and the elephant is an Eastern parable that provides an enduring lesson on how perception may be limited by context, as well as a fitting metaphor for systems thinking. If there is a complex system (the elephant) that one wishes to understand, in other words, then it is an injustice to visualize it from only a single perspective, or even a group of single, isolated perspectives (the blind men). In some versions of the tale, the varied interpretations lead to conflict, in others, consensus. For the purposes of this study, our "elephant in the room" is the practice of undergraduate research, captured as it emerges from a limited set of individual experiences into a multifaceted system that touches nearly all parts of university culture.

Overview and Literature Review

The history of undergraduate research has been well chronicled by others, but a major turning point in its development occurred in the 2000s, when George Kuh (and others) first identified it as one of several high-impact practices (HIPs; Kuh & Schneider, 2008). From that point onward, undergraduate research would no longer be limited to individual partnerships. Rather, the HIP model has served to extend the scope of targeted activities to the institutional level (Kuh, 2013). This wider lens has, in turn, extended the conceptual frameworks for many HIPs to encompass a broader range of practice across disciplines, roles, and academic units. In the case of undergraduate research, this bird's-eye view has engendered constructive conversations about the differentiated participation across disciplines (and super disciplines, e.g., the STEM [science, technology, engineering, and mathematics] fields; Ishiyama, 2002), which has led to the emergence of more nuanced definitions of the essential components of an undergraduate research learning experience that can be integrated into multiple contexts via a range of modalities (Beckman & Hensel, 2009; Healey &Jenkins, 2009; Hensel, 2012; Hu, Scheuch, Schwartz, Gayles, , & Li, 2008; Jansen et al., 2015; Kinkead, 2003; Mumford, Hill, & Kieffer, 2017; Zimbardi & Myatt, 2014).

To date, these emerging frameworks for undergraduate research have been driven by the need to assess (and, by extension, to enhance) their institutional impact, largely by collecting and aggregating the work being done by individual student, faculty, and academic units across a campus or campuses (DeAngelo, Mason, & Winters, 2016; Elgin et al., 2016; Fitzsimmons et al., 1990; Hensley, Shreeves, &Davis-Kahl, 2014; Kuh, 2003; Lopatto, 2004; MacDonald, Brown, & Swaby, 2019; Malachowski, Osborn, Karukstis, & Ambos, 2015; McDevitt, Patel, & Ellison, 2020; Nelson Laird, BrckaLorenz, Zilvinskis, & Lambert, 2014; Rogers & McDowell, 2015; Webber, Nelson Laird, & BrckaLorenz, 2013). Because of its HIP status, undergraduate research has been scrutinized especially heavily by researchers interested in its influence on student success, in the form of equity, access, persistence, and/or graduation (e.g., Eby et al., 2012; Jacobi, 1991; McLean & Howarth, 2008; Miller, Barnes, Miller, & McKinnon, 2013; Rogers &McDowell, 2015; Santos & Reigadas, 2004). A summary of the research indicates that the practice does indeed live up to its high-impact status, with gains noted across the board (Carter, Ro, Alcott, & Lattuca, 2016; Gilmore, Vieyra, Timmerman, Feldon, & Maher, 2015), yet scholars have also pointed out that these gains may or may not accrue at the same rate across different populations, disciplines, or institutions (Bangerra & Brownell, 2014; Y. K. Kim & Sax, 2009).

The consensus on the benefits of undergraduate research has allowed the focus of research to shift from questioning whether undergraduate research "works" to exploring instead how to make the practice more inclusive and equitable. A corollary to this shift in emphasis is an interest in identifying barriers to participation, whether these stem from (lack of) student motivation, faculty investment, disciplinary value, or institutional support (Bauman, Bustillos, Bensimon, Brown, & Bartee, 2005; Milem Chang, & Antonio, 2005). The majority of such studies, however, have continued to focus on the viewpoints of individuals, or groups of individuals, rather than examining the relationships between and among various stakeholders (Myers, Sawyer, Dredger, Barnes, & Wilson, 2018; Webber et al., 2013). Possible exceptions to this are the studies that have examined the intensive mentoring relationship between students and faculty, often a characteristic of undergraduate research projects, but even these studies have tended to focus on student outcomes, delineating psychosocial as well as cognitive benefits (Hu & Ma, 2010; Wallace, Abel, & Ropers-Huilman, 2000).

One of the barriers limiting comparative, interdisciplinary, multidisciplinary, and cross-institutional studies of undergraduate research is the emerging realization that the practice can take on different attributes relative to its context. Beckman and Hensel (2009) identified no less than eight axes along which beliefs about undergraduate research can range, including differences on who does what, for whom, when, how, and why (Figure 1).

Outcome	Origination	Participants	Position	Number	Research question	Disciplinary perspective	Audience
Process	Student-initiated	All students	Curricular	Collaborative	Original to students	Multi- or inter-disciplinary	Campus/community audience
↕	↕	↕	↕	↕	↕	↕	↕
Product	Faculty-initiated	Honors students	Co-curricular	Individual	Original to the discipline	Discipline based	Professional audience

Figure 1. Continua of beliefs regarding undergraduate research (adapted from Beckman & Hensel, 2009). Figure modified from figure in Mary Beckman and Nancy Hensel, "Making Explicit the Implicit: Defining Undergraduate Research," *CUR Quarterly*, 2009, 29(4): 40. Reproduced by permission of the Council on Undergraduate Research.

Researchers at McMaster University recently posited a ninth axis, curricular integration, ranging from the scaffold (across the curriculum) to the bookend (capstone) models (Perrella, Dam, Martin, MacLachlan, & Fenton, 2020). New categories continue to be added as different stakeholders emerge. These beliefs can be highly varied, with consensus unlikely to be found even within (much less between) disciplinary departments or programs, sometimes even within the same individual. As an HIP, undergraduate research has expanded to become a large umbrella encompassing a broad range of attitudes, values, and practices that often cut across formal roles and hierarchies.

As that umbrella expands, it may be an opportune time to consider new conceptual frameworks that shift the locus of analysis from individual engagement to institutional culture, with attention to how this multiplicity of views can be directed toward shared goals and the advancement of inquiry-based teaching and learning. Leveraging teaching transformation at the institutional level is a topic receiving much attention within the STEM disciplines, practitioners of which have articulated a number of theories of change intended to foster changes within both teaching practice and the broader context of institutional culture (Beach, Henderson, & Finkelstein, 2012). A seminal meta-analysis of these theories suggested that much attention has been paid to prescriptive (e.g., curriculum, policy) and emergent (e.g., intrinsically motivated faculty) approaches to change; but comparatively little attention has been paid to effecting change that is both emergent and institutional, what one set of researchers calls "developing a shared vision" (Henderson, Beach & Finkelstein, 2011). Part of the reason for the under-representation of this approach to change, however, is that it can be challenging both to effect change on such a broad (and deep) scale and to measure its impact.

Fortunately, systems thinking has emerged as a promising tool for understanding organizational culture, particularly in the case of phenomena that work outside of formal hierarchies or institutional silos. Within higher education, the application of systems thinking has been fueled by growing interest in recreating universities as teaching and learning communities, including an emphasis on interdisciplinary collaboration, shared governance, and collective decision making (Bui & Baruch, 2010; H. Kim & Rehg, 2018). In the systems framework, rather than viewing undergraduate research as a relatively static set of activities or stakeholders, it can be seen as a dynamic and evolving set of connected and interdependent elements that interact within the boundaries of the institution (Acaroglu, 2017a). When complex organizations such as universities and colleges are viewed through the lens of systems thinking, the object of analysis becomes the delineation of those lines of interdependence (or lack thereof), a process referred to as systems mapping (Meadows, 2008).

Systems mapping should not be confused with similar terms used in other contexts. It does not refer to multicampus university systems, for example, nor other forms of mapping, whether cartographic, social network, or concept/mind mapping. Rather, systems mapping is a strategic analytical tool that is often applied as a prelude to change, allowing researchers to frame challenges in ways that deepen understanding as well as illuminate pathways and bottlenecks which then, in turn, inform the development of potential solutions and new opportunities (Acaroglu, 2017a).

Participatory systems mapping, in which multiple stakeholders engage in systems mapping simultaneously through a process of individual and collective reflection, has been shown to foster a shared commitment to collective change in addition to the insights provided by the maps themselves (Király, Köves, Pataki, & Kiss, 2016). There is considerable promise, in other words, for the approach to serve two purposes: to simultaneously measure and develop a shared organizational culture across disparate stakeholders. This participatory systems-mapping process has recently showed considerable promise in taming other so-called "wicked" or highly complex problems in higher education (Király, Géring, Köves, Csillag, & Kováts, 2016), including student success in STEM disciplines (Chan-Hilton, 2019), long-term change in a college of engineering (Morelock, Walther, & Sochacka, 2019), the role of centers for teaching and learning (Chan-Hilton & Cruz, 2019), and developing a shared vision for the future of higher education (Géring et al., 2018). For the purposes of this study, we engaged in a participatory systems-mapping process in which 56 stakeholders came together to consider our "elephant"—the emerging culture of undergraduate research across our campus.

The Study

Context

The study took place at The Pennsylvania State University (commonly known as Penn State) a large, public university classified as doctoral with very high research activity, located in the northeastern part of the United States. Penn State also has 19 primarily undergraduate branch campuses that serve roughly 40% of the total number of undergraduate students (approximately 80,000). At this time, STEM majors on the main campus had long benefitted from sustained opportunities to assist with research as part of externally funded projects, including high-profile partnerships with the medical campus. Other units and campuses generally had less consistent engagement with externally funded projects (though it was prevalent in niche areas).

With the transition to the HIP model starting around 2012, undergraduate research at Penn State received more widespread support through the division of undergraduate education, including the provision of research and travel grants, an undergraduate research exhibition (with awards), and a competitive grant program to support undergraduates in independent summer research projects supervised by a faculty mentor. For the 2017–2018 academic year, the institution awarded 72 summer research grants and 297 grants for 352 students to travel to conferences for presentations and showcased 348 projects at the centralized research exhibition and over 250 at individual campus exhibitions. After an initial surge in activity, efforts to expand the practice beyond these levels, particularly across disciplines and campuses, appeared largely to have plateaued and it became increasingly apparent that a new approach would be required to advance the practice further. Before that could occur, there needed to be a greater understanding of all the factors enabling and inhibiting the growth and development of undergraduate research as a HIP.

Developing a shared vision of undergraduate research at Penn State has been an especially complex task, as the practice developed primarily through individual units within the organization.

Colleges, located on the largest campus of the university, and smaller individual campuses established independent practices and procedures to best support their unique faculty, students, and circumstances. University-wide programs and supports formed later in response to shared needs, leadership initiatives, and interest in centralized investment. Initiatives such as those listed above, for example, the all-university undergraduate research exhibition, were responsive to the efforts begun within the units. Consequently, colleges and campuses developed independent norms, beliefs, and practices prior to programs being generated from the central administration of the university.

Because of the autonomy granted to the colleges and campuses in the decentralized model of practice at Penn State, it is not uncommon for these units to have unique cultural identities. Identities are built around fundamental differences between units in terms of disciplinary expertise, location, community context, and resources. For example, while all tenure-track faculty are required to actively participate in a productive research agenda, those who are located at the largest campus routinely have significantly reduced teaching responsibilities and greater access to appropriate physical and material resources. Faculty who are involved with undergraduate research frequently mention the need to reward supervision and mentoring, which is not currently articulated in the university standards, and reporting standards vary widely. This research project serves as an effort to begin to discern the range of current views, as a precursor for strengthening a shared vision and identifying desired directions for change related to the practice of undergraduate research throughout the university.

The Participatory Systems-Mapping Process

In the spring semester of 2020, the senior leader who oversees undergraduate research at Penn State issued a university-wide invitation asking for volunteers (from faculty members, students, and administrative staff) to engage in "collaborative conversations" via a participatory systems-mapping session (Acaroglu, 2017b; Chan-Hilton, 2019; The Omidyar Group, 2019). The invitation was sent via email to previously established distribution lists for participants in undergraduate research activities across the university (including all campuses and colleges). Unit leaders were enjoined to share the invitation with others who might be interested. In addition, printed flyers were distributed at known gathering places for students and faculty on the main campus. Sixty-three faculty, staff, and students volunteered to take part in the first three systems-mapping sessions.[1] During each of the three sessions, the process was guided by two questions, "What impacts undergraduate research?" and "How might contributing factors be connected and interrelated?"

The process was designed to be generative, providing participants from a variety of disciplines and roles with opportunities to develop their ideas organically while providing guidance to facilitate systems thinking. During a 2-hr session, participants worked through two primary stages: developing a systems map and creating a more focused feedback loop for one identified theme, with each activity scaffolded by a combination of ideation, consensus building, and reflective activities (Table 1).[2]

Table 1. The systems-mapping process (by stage, description, modality, and artifact).

Stage	Description	Modality	Labels	Specific Artifact
1. Systems map	Node generation	Individual	Inhibitors/enablers	Sticky notes
	Clustering	Small group discussion	Themes/arrows	Systems map (visual diagram)
	Reflection	Individual and small group		Stories

[1] Two additional planned sessions were postponed because of the university's response to the COVID-19 pandemic in March.

[2] For those wishing to fully replicate this version of the participatory systems-mapping process, a detailed facilitators' guide is available upon request to the authors.

Stage	Description	Modality	Labels	Specific Artifact
	Whole group reflection	Gallery walk	Missing voices	I wonder… statements
2. Feedback loop	Node generation	Small group discussion	Structural, attitudinal, or transactional	Sticky notes
	Directionality	Small group discussion	Arrows	Feedback loop (visual diagram)
	Reflection	Individual and small group		Stories

This participatory systems-mapping process was designed specifically for these sessions, taking into account time constraints, audience, and plurality of disciplines and roles. In addition to generating a systems map, the first stage was intended to prepare participants for the more focused, deeper dive in the second activity, a feedback loop. The facilitators chose not to provide participants with a pre-established definition of undergraduate research, and they emphasized throughout the process that the intended goal was to get a better of understanding of the current culture of undergraduate research at Penn State, not to identify potential solutions or articulate next steps, tasks that would need to be addressed by future forums. The design also included attention to the composition of the small groups, which were engineered to include as broad a representation of roles (e.g., student, faculty, staff) and disciplines as possible, given the characteristics of those present at each session.

Participants

Participation in the sessions was voluntary; thus it is presumed that those willing to dedicate time to the process likely were supporters, even advocates, of undergraduate research. As a biased sample population, then, these results are likely not representative of the university as a whole. Participants noted an under-representation of students, advanced graduate students, senior administrators, and detractors or nonengagers, though at least one representative from each of these groups was present for each of the three sessions. The session demographics could, however, serve as a rough proxy for which roles or disciplines consider themselves stakeholders in undergraduate research at Penn State.

Of the 56 participating and consenting participants in the systems-mapping process, faculty, especially tenured faculty, were slightly over-represented (56%), which is consistent with emerging trends of tenured faculty taking on stronger advocacy roles in undergraduate research (Figure 2A). Given the history of undergraduate research, it is not surprising to see STEM disciplines (faculty and students) heavily represented (50%), but the transition to the HIP model is evident from the participation of a range of other disciplines, collectively constituting nearly 50% of the total (Figure 2B). All major academic colleges had at least one representative (faculty, staff, and/or student) present in the sessions, with the exception of Business and Education.

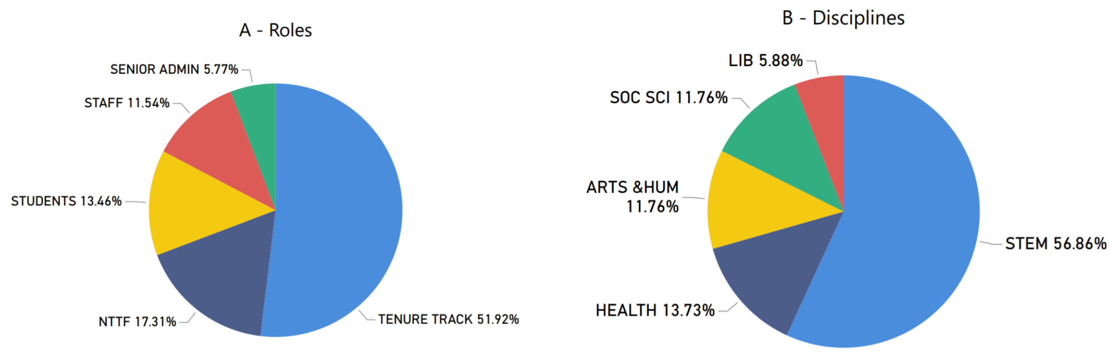

Figure 2. Participatory systems-mapping participants by (A) role and (B) by discipline. Senior Admin = Administrators; NTTF=Non-tenure track faculty; HUM = humanities; STEM – science, technology, engineering, and mathematics; LIB=Libraries; SOC SCI=Social Sciences.

Because of the distinctive institutional structure of Penn State, the session facilitators hosted one session at a campus located several hours east of the main campus. Altogether, session participants included representatives from eight different campuses, and constituents (faculty, staff, and students) from the main campus made up just over half of all participants. This latter representation would likely have decreased with the inclusion of the two postponed sessions, both of which were scheduled to be held on campuses other than the main campus.

Methods of Analysis

As Figure 1 demonstrates, the participatory systems-mapping process produced seven artifacts for each group of 3–5 participants. Those artifacts included a systems map (visual diagram), a worksheet (text with questions, stories, and structured reflections), a feedback loop (visual diagram), and a final story (text). For the purposes of analysis, the researchers transcribed the elements in each of the visual artifacts into a spreadsheet, including text entries for the stories and "I wonder" statements.

Analysis of the artifacts took place in three stages. First, the research team aggregated evidence from across all artifacts generated and individually analyzed evidence from each artifact type (e.g., systems map, story) separately. In Stage 2, the themes and outcomes identified by the individual researchers (inductively) were integrated and a consistent coding scheme developed, which was then applied to all artifacts included in the study (deductively). The final stage involved an additional round of thematic coding, in which the research team looked at changes that occurred both within and across groups, as the participants engaged more deeply from the first map (undergraduate research system) to the second visualization (the feedback loop, focused on a theme). Formal analysis was supplemented by observational data recorded by the event facilitators. The components of the systems maps (n = 14), including nodes, clusters, and connections (see Figure 3), were thematically coded, counted, and then analyzed using descriptive statistics. The components of the feedback loops (nodes, directionality, attributes) were similarly thematically coded, counted, and then analyzed using descriptive statistics (Figure 4).

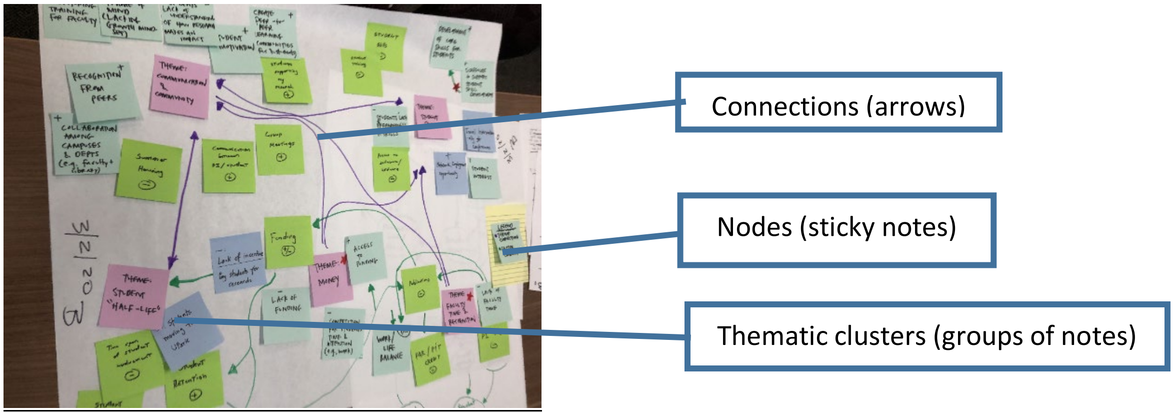

Figure 3. Example of an undergraduate research systems map.

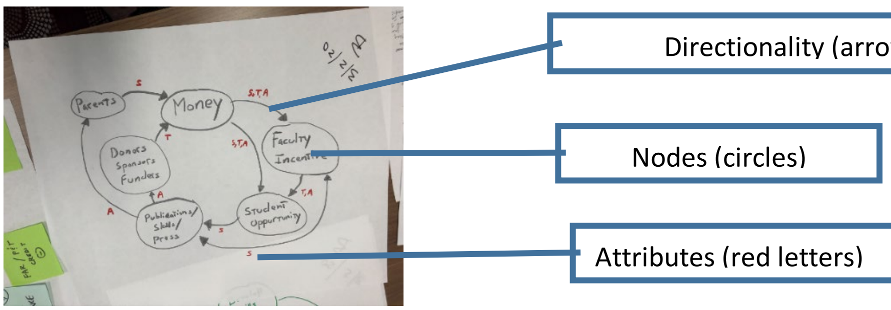

Figure 4. Example of an undergraduate research feedback loop.

The stories and questions on the worksheet were analyzed using a combination of discourse analysis and emergent coding, described in more detail below. Artifacts and themes were tracked using Excel spreadsheets.

Results

Part 1: Plurality

Our analysis of the visual artifacts that the participants generated through these systems-mapping sessions (e.g., systems maps, feedback loops) serves to illuminate the intersections and interconnectedness between programs, people, and ideas. Rather than focusing on a relatively narrow set of best practices at a single place along the continua of undergraduate research beliefs and practices, our findings affirm that the culture of undergraduate research can be viewed as a dynamic, interconnected, and pluralistic system.

Attitude clusters. The variability in definitions of research across disciplines has been identified as a significant factor in prior studies of undergraduate research as an HIP but our results suggest that additional patterns of variability regarding participation and purpose may also be present (Beckman & Hensel, 2009). These patterns resulted in attitudinal clusters, drawn by connecting factors identified in Beckman and Hensel's continua (Table 2). Note that evidence from the maps did not provide sufficient data to include the remaining two continua—individual/collaborative and disciplinary/multidisciplinary—from Beckman and Hensel's original model. The clusters are listed in order of prevalence.

Table 2. Attitude clusters regarding undergraduate research features (from nodes on systems map).

Cluster	Value	Initiator	Participants	Integration	Origins	Audience	Priorities
1	Product	Faculty	Honors students	Cocurricular	Discipline	Profession al	Resources, especially funding
2	Process	Student	All students	Cocurricular	Student	Campus/c ommunity	Time, faculty and student
3	Process	Faculty	All students	Curricular	Both	Campus/c ommunity	Communica tion, especially outside the discipline
4	Both	Both	All students	Cocurricular	Discipline	Both	Definitions and boundaries

A fifth cluster, embracing perspectives absent from the systems-mapping sessions, could perhaps be posited and added to this emerging typology. Further analysis suggests that each attitude cluster can be correlated with the perception of inhibitors and enablers, which, in turn, reveal what the participants perceive to be institutional priorities in supporting undergraduate research (column 8, Table 2). It should be noted that these clusters were generated primarily from the experiences of the individual participants prior to the systems-mapping sessions and significantly shaped the dynamics of the subsequent activities.

Undergraduate research as an institutional commodity. After completing their feedback loops, participants were asked to consider and label factors that are primarily structural, attitudinal, or transactional in nature (as time permitted; Table 3). Our analysis of these factors indicates a prominence of attitudinal factors (e.g., beliefs, values, and norms) over structural (resource environment) or transactional (process and policy) factors.

Table 3. Feedback loops: Structural, attitudinal, and transactional factors.

Factor type	Administratio n	Communicatio n	Cultur e	Facult y	Resource s	Student s	Total no. of factors (without and with double coded items)
Structural	1	2	6	8	18	7	37/4242
Attitudinal	1	1	23	7	5	14	40/5151
Transaction al	—	5	10	12	11	9	33/4747
Total	2	8	39	27	34	30	110/140

Note. Structural factors relate to the physical, institutional, or social environment; attitudinal factors are beliefs, values, or norms that affect how groups behave; and transactional factors are processes and interactions (The Omidyar Group, 2019). These definitions were provided to participants. Totals are inclusive of factors that were double-coded.

This shift was particularly evident in how both faculty and students perceived the value of research as an institutional commodity, a new continuum we propose should be added to the growing list. For those stakeholders who fell in the first attitudinal cluster (see Table 2), research is faculty initiated and students are engaged as assistants (e.g., *students supporting my research*)[3], often in laboratory-based work that requires skilled labor. For those in this group, student motivation to participate was not a central issue; rather the impetus was on students to take the initiative and get involved (e.g., *lack of initiative by student to contact professor*). In this view, research is treated as a scarce commodity, both rivalrous, for example, access to research by one person prevents access by another (*we get lots of inquiries but we can only take a few)* and excludable, for example, it is desirable to limit participation (*it takes longer to train an undergraduate than to do it myself)*. Questions of expanding undergraduate research then focus on changes to both supply and demand (e.g., *professors lack the need to have an undergraduate researcher, especially freshmen and sophomores*).

For those who viewed undergraduate research primarily as an extension of teaching (Cluster 2 in Table 2), on the other hand, research functions more like a club good, meaning that access to research by one person does not preclude access by another; but participation is limited by the capacity of the institution and the bandwidth of faculty to support such intensive teaching practices at scale. This perspective is frequently reflected in the articulation of trade-offs such as this one: *[How do we determine] which students to invest time into (strong students take less work but weak students benefit most)?*

For stakeholders in this cluster, the goal is to expand membership in the club (e.g., *the goal [is] to include more people*), so to speak, which leads, in turn, to addressing questions of equity and access, for example, *how might we as faculty increase exposure and access to research*? *I wonder how to better "sell" research to students to overcome barriers*? Expanding membership requires a shift toward a more nuanced and wide-ranging understanding of what factors influence student participation. These factors range from attitudes (*how [do students'] interests and career goals influence their desire to engage?*), beliefs (*who "does" research*), self-concept (*student frame of mind/growth mindset*), belonging (*peer learning communities, organizations, events*), and motivation (*curiosity fulfilled*) to resources (*I wonder how programs like the grant affect attitudes from students*). The prevailing attitude from this cluster is, as one respondent put it quite eloquently, *if you don't already fit the model, we have to figure out how to include you.*

Part 2: Shared Culture

In the second section of our findings, the focus shifts from the nodes and labels generated in both stages of the mapping process to the connections and the stories. Because of the nature of our subject matter, the methods applied for this section are more reflective of norms associated with the humanities and could be characterized as a quasiethnography of the culture of undergraduate research at a large and highly complex public university.

Shared agency. The initial analysis of the nodes in the systems maps depicted faculty participation in undergraduate research as weighed primarily through opportunity costs (e.g., other activities, such as teaching and research that would have to be given up to participate in mentoring undergraduate students), and student participation by a lack of knowledge, whether of the value of undergraduate research or of opportunities in which to engage. What emerged through the reflective processes was a growing sense of shared calculus, in which the perspectives of both parties (e.g., faculty and students) were taken into consideration, for example, *What can we do to prepare and motivate students to participate without sinking disproportionate time/resources [into the process]?; there is a gap between attitudes towards undergraduate research and the faculty which affects the knowledge the students have of the opportunities*; *engaged faculty who understand undergraduate research attract interested students*.

That calculus also reflected a shift in the locus of agency. Initial inputs tended to focus on levers external to the individuals, most often the university, the main campus, or its representatives

[3] Quotations from the systems mapping artifacts appear in italicized text throughout the remainder of the document.

(e.g., *the key is administrative buy-in; it all comes down to leadership; how can [the main campus] support us?*) or at times an unnamed actor, hidden by the passive voice (e.g., *faculty efforts need to be recognized and their time needs to be rewarded*). By the end of the session, the rhetoric shifted toward both active voice and first person plural (e.g,. we) and reflected a growing awareness of collective agency (e.g., *How do we change perceptions, expectations, and culture at [Penn State] (without money)?*) and responsibility (e.g., *if only one factor could be changed, which would have the biggest ripple effect?*"; *will we settle for a series of small victories for some or are we interested in changing the landscape for all?).*

Developing systems thinkers. One of the last actions the participants took was to turn their feedback loops into a story, or narrative account, that captures the inherent dynamism of the visual process. This was not, however, their first story of the day. Earlier, they had worked together to write the story of their shared systems maps. Participation in the second story was not as consistent, as the exercise likely fell victim to being at the end of a long session, but a comparison of the insights gained from the first to the second story reveals a rather profound shift toward collective systems thinking.

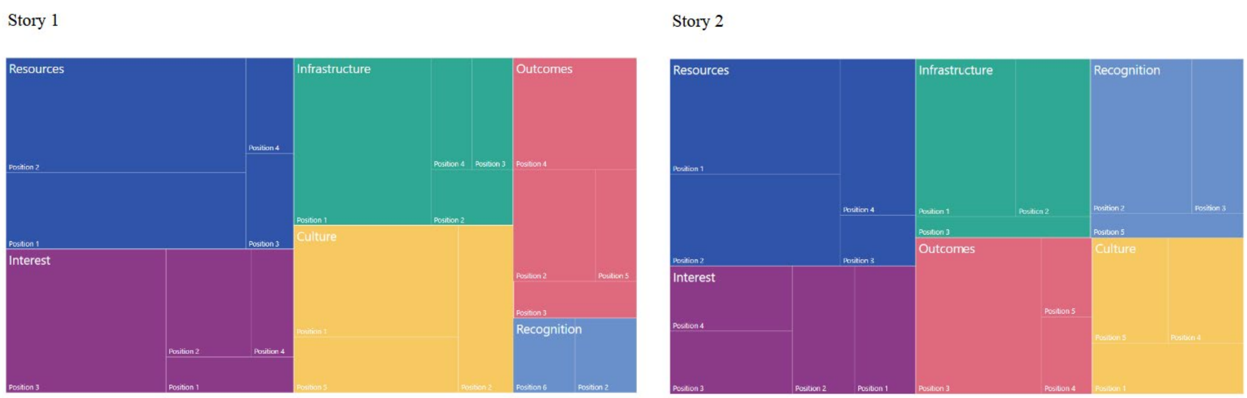

Figure 5. Systems-mapping exercise: Story themes (with positionality).Note: These figures show the categories and the order in which the groups organized the categories (position) within stories one and two. The size of each category's box represents the proportion of times the category was presented in the aggregate data for each of the two stories.

After coding the first and second stories, six categorical descriptors emerged: resources, infrastructure, outcomes, interest, culture, and recognition (see Table 4 for coding details). These six categories were consistently represented across groups and stories. However, the first and second stories differed in composition, number of categories represented, and directionality. In the first story (based on the overall systems map), the groups constructed stories with fewer categories; half the groups had stories with only two to three categories (see Figures 5, 6, and 7). While all coded categories were present in the aggregate of the first stories, the number of categories varied within groups, between two and six. Further, the links between categories was unidirectional (e.g., Category 1 affects Category 2, Category 2 affects Category 3; Figures 6 and 7). Across all the groups, there were only two instances of arrows originating from a later category and looping back to a previous category.

Table 4. Examples of coding scheme for Stories 1 and 2.

Participant descriptors	Coded category
University website, recruitment efforts, programming, undergraduate research office, advertising	Infrastructure
Funding, time, space	Resources

Participant descriptors	Coded category
Inclusion in promotion and tenure, increase in prestige, increase in visibility	Recognition
Increased productivity, published papers, presentations, job training, job opportunities, increase professionalism	Outcomes
Faculty and student interest	Interest
Value of undergraduate research at the university, administration support and buy in	Culture

Story 1:

"Funding and resources are a top priority"

(resources lead to outcomes)

"Administration buy-in and support"

(infrastructure leads to outcomes)

Story 2:

"Resources *(resources)* feed more collaboration *(outcomes)*, which feeds student REUs *(resources)* that benefit student progress *(recognition, outcomes, and culture)*, which feeds back to administration support *(resources and culture)* and faculty prestige and productivity *(recognition and outcomes)*"

Figure 6. Example of one group's first and second stories; categories in parentheses and italics exemplify how the components of the stories were coded in the study. The first story exemplifies the inclusion of three categories: resources, infrastructure, and outcomes. However, there are two siloed responses, with only one category unidirectionally linked to another. In Story 2, the group included four categories: resources, outcomes, recognition, and culture. In this story, the links among categories were more intertwined, categories were linked back to other categories, and there is not a clear linearity to the story, demonstrating a systems-thinking approach to Story 2. REUs = Research experiences for undergraduates.

By the second story (based on the feedback loop of one theme in the overall systems map), the perspectives of the groups seemed to coalesce into a shared vision of the system. The most noticeable shift occurred as groups moved from siloed, unidirectional association between categories to tighter, interconnected relationships between the categories, demonstrating a transition from a collection of disparate connections between categories to an interconnected, systems view of the factors that affect undergraduate research (e.g., Figures 6 and 7). Further, while all six categories were again represented across stories, the composition was far more similar among groups. All the groups tended to have three or more categories and all but one group presented resources and infrastructure as either their first and second categories (not all groups used the same order). Many groups then presented recognition, followed by outcomes and culture. Finally, there were many more instances of arrows originating from a later category and linking back to other categories (Figure 7B), demonstrating the interdependence of the variables, a key component of systems thinking (D. H. Kim, 1999). Remarkably, it would appear that what emerged from these three independent sessions was a shared vision of a pluralistic, integrated system of undergraduate research at Penn State.

The results from the first story confirm the attitudinal clusters identified previously in this study. The groups would typically form unidirectional links between two categories (e.g., resources affect outcomes; Figure 7A). While the second stories integrated the same number of categories, these now were joined by more complex linkages between them. For instance, resources are instrumental in setting the stage for successful participation in undergraduate research. These resources support students and mentors during the research experience, increasing the probability of publications and presentations. These outcomes lead to recognition and prestige at the local, national, and international level, which sets the stage for acquiring more resources in the form of external funding (recognition feeding back on resources). Publications, presentations, and recognition gained from participating in undergraduate research contribute to a culture of the importance of undergraduate research at Penn State. As the culture evolves and grows, the likelihood of more resources and infrastructure devoted to undergraduate research grows as well, beginning the cycle anew.

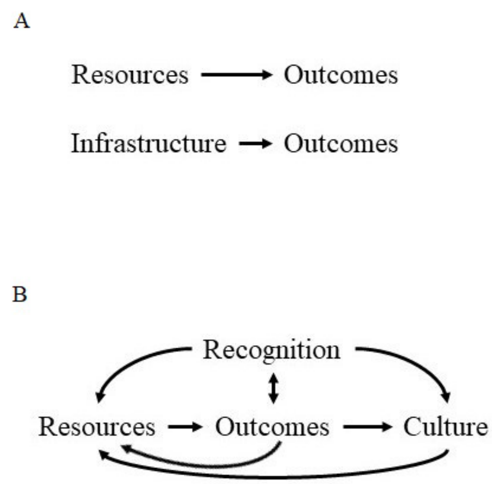

Figure 7. The institutional cycle of the undergraduate research system as depicted in the first (A) and second (B) story.

Telling our story. This glimmer of a shared vision is affirmed by the increasingly sophisticated representational strategies used by the participants. A system is a large, complex, intangible, and dynamic thing that can be challenging to convey, whether in words or pictures, so many of the participants used metaphors. In several cases (n = 4), there was reference to awareness of a shifting systemic paradigm (e.g., *traditional implementation* (as an inhibitor) or the need to subvert a perceived dominant paradigm (e.g., *break out of STEM as the only legitimate undergraduate research*; *I wonder how undergraduate research can be inverted*).

Others (n = 3) evoked or depicted a spoke or wheel model (e.g., *everything radiates from and goes back into the values*), with one particularly memorable extended metaphor: *There are different moving parts in undergraduate research—like a wagon with wheels; all the parts need to be properly "oiled" maintained with a continued pipeline of supplies. And the overall system should be driven by the motivation/impact/purpose fuel that in the end makes all the involved parties happy/content.* Other less common visual and written metaphors included webs, spirals, ecosystems, and landscapes. Whatever the metaphor, it was evident that undergraduate research at Penn State was no longer perceived as just a collection of stakeholders, a list of participants, a description of programs, a discipline-based practice, or an administrative problem; rather it was all of these, part of a flawed, yet vibrant, community in which we all participate.

Discussion and Implications

One of the primary goals of this systems-mapping process was to get a clearer sense of the current ecosystem of undergraduate research at Penn State. This leads to the question, if we were to take each of the systems maps that the participants created and overlay them, would we find our elephant? Taken as a whole, the culture of undergraduate research took shape in several ways through the mapping process. First, the process provided evidentiary support for previous assumptions held by the stakeholders closest to the process; second, the maps illuminated key areas of intersections (or lack thereof) that were previously unknown; and finally, the stories enriched the complexity of the tasks that lie ahead.

In many ways, it could be argued that our findings have made it more, rather than less, difficult to foster a shared vision of undergraduate research at Penn State. By viewing the practice through an institutional rather than an individual or disciplinary lens, we found that our vision became further refracted, like a prism, increasing rather than simplifying the plurality of policy, practice, and people involved. After all, our findings suggest at least two new continua to add to Beckman and Hensel's (2009) initial list—institutional priority and commodity value---with the open possibility for more. That said, this plurality should not necessarily be viewed as a problem to be solved but rather as a means for ensuring the development of a shared vision that is fully inclusive.

These findings also reflect the intentional blending of approaches used in the presentation of this research. We hope that those looking for the signposts of a conventional social science approach may find meaning in the mixed methods analysis of the visual artifacts; and those from the arts and humanities may appreciate the emphasis on storytelling (whether as evidence or in the presentation). One of our implicit findings is the need for raised levels of awareness and tolerance for multiple pathways for constructing legitimate research, including that on undergraduate research as an HIP. Those pathways include various ideas of the purpose of research. In the case of this study, the outcome is not primarily direct applications or solutions but rather greater insight into the complex, ambiguous, indeed, arguably wicked challenge of transforming culture.

We may be getting ahead of ourselves and of the evidence from our study. As was emphasized during the sessions, the initial systems-mapping process was not intended to identify or provide solutions, though participants found themselves often tempted to do so. Rather, the purpose was to capture a more robust understanding of how the current system works across multiple modalities, disciplines, and campuses, and for this to serve as a baseline for future action. Our goal was to take the first steps toward developing that shared vision, knowing that this would be just one small part of a larger process of transformation, one that will need to embrace a robust and multifaceted theory of change as it moves forward.

From the perspective of the senior administrator who sponsored this process, there were several key takeaways that emerged:

- A need to intentionally focus on cultivating *a shared vision of undergraduate research*, including the need to define the practice in such a way to include the plurality of voices, embrace the complexity of processes, and reflect the distinctive identity of the institution. And that culture may include other forms of symbolic meaning making, including the creation of a hub at the spokes of the wheel, for example, a centralized undergraduate research office.

- A strong need to foster *community (or communities) of undergraduate research*, whether within stakeholder groups (e.g., student organizations), across groups (e.g., networking events), or with other campuses, including those outside of the institution. And these communities need to embrace a wide range of stakeholders, allowing many more members to "join the club," which necessitates addressing existing inequities.
- A need to recognize how the layers of the institution (university, campus, college, department) are intricately woven together. To change a culture will require *active participation at each level* with attention to the ways that decisions impact all aspects of the university. The process has empowered senior leadership to address issues more effectively, having identified the general desire for cohesive community and the interconnections between the layers of institutional governance.
- A need for this culture, these communities, and this shared vision to have a more *visible presence*, from celebrating successes to, as one participant put it, bringing both our deliverables and our stories to the table. And part of that will stem from sharing the story of these systems-mapping sessions.

There may be questions about whether this process served as a sufficiently robust basis for such actions. As noted above, participants were self-selected, leading to a positive bias as well as the absence of voices of opposition or indifference. And while efforts were made to be as inclusive as possible, the fact remains that Penn State is an extremely large, heterogeneous system, and the data presented in the current study do not have the resolution to finely discern if different patterns emerge from, for instance, different campuses, disciplines, or stakeholder positions (e.g., administration, faculty, students). More work needs to be done to refine our understanding, enrich our database of perspectives, and seek out those who may not be intrinsically motivated to add their voice. As one participant asked, *I wonder how to include everyone's voice that has something to share?*

It remains an open question, too, whether these goals and action items could have been achieved using a different process, perhaps one that is more efficient (each session took 2 hr) or more expansive (the process included 56 stakeholders, the majority of whom were faculty from the main campus). A survey, for example, would reach more people and require less of a time commitment to complete. When we analyzed the initial, individual responses from our participants in the mapping process, however, we did not learn anything especially new, which suggests that we might not learn a great deal from a survey either. Other scholars have noted the challenges and opportunities faced by faculty, staff, and students in expanding undergraduate research elsewhere, and many of those same challenges and opportunities apply to current conditions at Penn State. A survey or other conventional needs assessment tool, such as a SWOT (strengths, weaknesses, opportunities, and threats) analysis, would likely have brought us to a similar place to an analysis of the nodes that our participants indicated on their systems maps.

The value of the systems mapping did not come from identifying challenges and opportunities—that is the point from which the process started. Rather, the value came in illuminating the interconnections or interconnectedness of these challenges and opportunities through multiple disciplinary lenses. You could say that the value came not from the nouns but from the verbs, i.e., not the nodes themselves but the arrows that connected the nodes or the stages in the feedback loops. By enhancing our understanding of how each aspect effects the other, we can become more effective levers of change, even in an organizational environment as complex as Penn State.

It is well known that an effective strategy for breaking down silos is to get stakeholders in the same room and talking to each other; so we did expect similarly positive benefits to come from having faculty, staff, and students from different disciplines and campuses discuss undergraduate research, regardless of the method used to facilitate that conversation. The structure of the systems-mapping process, too, was intended to develop the ability of these stakeholders to visualize undergraduate research at Penn State as a system. What was less expected was the degree to which a shared vision of that system emerged, even from groups acting independently of one another, and how the ability of our stakeholders to tell the story of the systems of undergraduate research at Penn State has the potential to serve as a basis for more profound cultural change in the future. It could be said that the systems-mapping process acted on two levels, the first as the basis of strategic planning (as well as a research project), and the second as the basis of changing how we perceive (and think about) the values, beliefs, and behaviors of all of the stakeholders who make up our undergraduate research—even our university—community. In other words, not only did we find our elephant, but we may also have found a path through the jungle.

References

Acaroglu, L. (2017b). *Tools for systems thinkers: Systems mapping.* Disruptive Design. Retrieved September 20, 2017 from https://medium.com/disruptive-design/tools-for-systems-thinkers-systems-mapping-2db5cf30ab3a

Acaroglu, L. (2017a). *Tools for systems thinkers: The 6 fundamental concepts of systems thinking.* Disruptive Design. Retrieved September 21, 2017 from https://medium.com/disruptive-design/tools-for-systems-thinkers-the-6-fundamental-concepts-of-systems-thinking-379cdac3dc6a

Antunes, P., Stave, K., Videira, N., & Santos, R. (2015). Using participatory system dynamics in environmental and sustainability dialogues. In. M. Ruth (Ed.), *Handbook of research methods and applications in environmental studies* (pp. 346–374). Cheltenham, England: Elgar.

Bangerra, G., & Brownell, S. E. (2014). Course-based undergraduate research experiences can make scientific research more inclusive. *CBE—Life Sciences Education*, *14*, 602–606. https://doi.org/10.1187/cbe.14-06-0099

Bauman, G. L., Bustillos, L. T., Bensimon, E. M., Brown, M. C., II, & Bartee, R. D. (2005). *Achieving equitable educational outcomes with all students: The institution's roles and responsibilities* (Making Excellence Inclusive initiative). Washington, DC: American Association of Colleges and Universities.

Beach, A. L., Henderson, C., & Finkelstein, N. (2012). Facilitating change in undergraduate STEM education. *Change: The Magazine of Higher Learning*, *44*(6), 52–59. https://doi.org/10.1080/00091383.2012.728955

Beckman, M., & Hensel, N. (2009). Making explicit the implicit: Defining undergraduate research. *Council on Undergraduate Research Quarterly*, *29*(4), 40–44.

Bui, H., & Baruch, Y. (2010). Creating learning organizations in higher education: Applying a systems perspective. *The Learning Organization*, *17*(3), 228–242. https://doi.org/10.1108/09696471011034928

Carter, D. F., Ro, H. K., Alcott, B., & Lattuca, L. (2016). Co-curricular connections: The role of undergraduate research experiences in promoting engineering students' communication, teamwork, and leadership skills. *Research in Higher Education*, *57*, 363–393. https://doi.org/10.1007/s11162-015-9386-7

Chan-Hilton, A. (2019). Student success and retention from the perspectives of faculty and students. In *Proceedings of the American Society for Engineering Education Illinois-Indiana Section Conference.* https://doi.org/10.5703/1288284316914

Chan-Hilton, A. B., & Cruz, L. (2019). Crossing the streams: Improvement science, educational development and systems theory in higher education. In R. Crow, B. N. Hinnant-Crawford,

& D. T. Spaulding (Eds.), *The educational leader's guide to improvement science: Data, design and cases for reflection*, 71-90. Sterling, VA: Myer/Stylus.

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

Eby, L. T., Allen, T. D., Hoffman, B. J., Baranik, L. E., Sauer, J. B., Baldwin, S., ... Evans, S. C. (2012). An interdisciplinary meta-analysis of the potential antecedents, correlates, and consequences of protégé perceptions of mentoring. *Psychological Bulletin*, *139,* 441–476. https://doi.org/10.1037/a0029279

Elgin, S. C. R., Bangera, G., Decatur, S. M., Dolan, E. L., Guertin, L., Newstetter, W. C., ... Labov, J. B. (2016). Insights from a convocation: Integrating discovery-based research into the undergraduate curriculum. *CBE—Life Sciences Education*, *15*. https://doi.org/10.1187/cbe.16-03-0118

Fitzsimmons, S. J.,Carlsen, K., Kerpelmen, L.C., & Stoner, D. 1990). *A preliminary evaluation of the Research Experiences for Undergraduates (REU) Program of the National Science Foundation*. Washington, DC: National Science Foundation.

Géring, Z., Király, G., Csillag, S., Kováts, G., Köves, A., & Gáspár, T. (2018). Applying participatory backcasting to study the future of higher education. *Journal of Futures Studies*, *22*(4), 61–82.

Gilmore, J., Vieyra, M., Timmerman, B., Feldon, D., & Maher, M. (2015). Undergraduate participation and subsequent research performance of early career STEM graduate students. *The Journal of Higher Education*, *86*, 834–863. https://doi.org/10.1080/00221546.2015.11777386

Healey, M., & Jenkins, A. (2009). *Developing undergraduate research and inquiry*. Heslington, UK: Higher Education Academy.

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

Hensel, N. (Ed.) (2012). *Characteristics of excellence in undergraduate research (COEUR)*. Washington, DC: Council on Undergraduate Research. www.cur.org/assets/1/23/COEUR_final.pdf

Hensley, M. K., Shreeves, S. L., & Davis-Kahl, S. (2014). A survey of library support for formal undergraduate research programs. *College and Research Libraries*, *75*(4), 422–441. https://doi.org/10.5860/crl.75.4.422

Hu, S., & Ma, Y. (2010). Mentoring and student persistence in college: A study of the Washington State achievers program. *Innovative Higher Education*, *35,* 329–341. https://doi.org/10.1007/s10755-010-9147-7

Hu, S., Scheuch, K., Schwartz, R., Gayles, J. G., & Li, S. (2008). Reinventing undergraduate education: Engaging college students in research and creative activities. *ASHE Higher Education Report*, *33*(4), 1–103.

Ishiyama, J. (2002). Does early participation in undergraduate research benefit social science and humanities students? *College Student Journal*, *36*(3), 381–387.

Jacobi, M. (1991). Mentoring and undergraduate academic success: A literature review. *Review of Educational Research*, *61*, 505–532. https://doi.org/10.3102/00346543061004505

Jansen, D. A., Jadack, R. A., Ayoola, A. B., Doornbos, M. M., Dunn, S. L., Moch, S. D., Moore, E., & Wegner, G. D. (2015). Embedding research in undergraduate learning opportunities. *Western Journal of Nursing Research*, *37*(10), 1340–1358. https://doi.org/0.1177/0193945915571136

Kim, D. H. (1999). *Introduction to systems thinking*. Waltham, MA: Pegasus Communications.

Kim, H., & Rehg, M. (2018). Faculty performance and morale in higher education: A systems approach. *Systems Research and Behavioral Science*, *35*(3), 308–323. https://doi.org/10.1002/sres.2495

Kim, Y. K., & Sax, L. J. (2009). Student–faculty interaction in research universities: Differences by student gender, race, social class, and first-generation status. *Research in Higher Education*, *50*(5), 437–459. https://doi.org/10.1007/s11162-009-9127-x

Kinkead, J. (2003). Learning through inquiry: An overview of undergraduate research. *New Directions for Teaching and Learning*, *93*, 5–17. https://doi.org/10.1002/tl.85

Király, G., Géring, Z., Köves, A., Csillag, S., & Kováts, G. (2016). Constructing future visions about higher education with participatory methods. In J. Huisman & M. Tight, Ed. *Theory and method in higher education research* v. 2 (pp. 95–114). London, England: Emerald Group.

Király, G., Köves, A., Pataki, G., & Kiss, G. (2016). Assessing the participatory potential of systems mapping. *Systems Research and Behavioral Science*, *33*(4), 496–514. https://doi.org/10.1002/sres.2374

Kuh, G. D. (2013). Promise in action: Examples of institutional success. *New Directions for Higher Education*, *2013*(161), 81–90. https://doi.org/10.1002/he.20048

Kuh, G. D. (2003). What we're learning about student engagement from NSSE: Benchmarks for effective educational practices. *Change: The Magazine of Higher Learning, 35*(2), 24–32. https://doi.org/10.1080/00091380309604090

Kuh, G., & Schneider, C. (2008). *High impact educational practices: What they are, who has access to them, and why they matter*. Washington, DC: American Association of Colleges and Universities. Retrieved from http://www.neasc.org/downloads/aacu_high_impact_2008_final.pdf

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First findings. *Cell Biology Education*, *3*(4), 270–277. https://doi.org/10.1187/cbe.04-07-0045

MacDonald, A. B., Brown, A. M., & Swaby, K. (2019). *UREP: Model for implementing and validating undergraduate research and other HIPs* (Campus presentation). Available at http://hdl.handle.net/10919/89520

Malachowski, M., Osborn, J. M., Karukstis, K. K., & Ambos, E. L. (2015). Realizing student, faculty, and institutional outcomes at scale: Institutionalizing undergraduate research, scholarship, and creative activity within systems and consortia. *New Directions for Higher Education*, *2015*(169), 3–13. https://doi.org/10.1002/he.20118

McDevitt, A.L., Patel, M.V., & Ellison, A.M. (2020). Lessons and recommendations from three decades as an NSF REU site: A call for systems-based assessment. *Ecology and Evolution* 10: 2710– 2738. https://doi.org/10.1002/ece3.6136

McLean, M., & Howarth, F. C. (2008). Does undergraduate student research constitute scholarship? Drawing on the experiences of one medical faculty. *Journal of the Scholarship of Teaching and Learning*, *8*(1), 72–87.

Meadows, D. (2008). *Thinking in systems: A primer* (D. Wright, Ed.). White River Junction, VT: Chelsea Green Publishing.

Milem, J. F., Chang, M. J., & Antonio, A. L. (2005). *Making excellence inclusive: A research-based perspective* (Making Excellence Inclusive initiative). Washington, DC: American Association of Colleges and Universities.

Miller, J. M., Barnes, J. C., Miller, H. V., & McKinnon, L. (2013). Exploring the link between mentoring program structure and success rate: Results from a national survey. *American Journal of Criminal Justice*, *38*, 439–456. https://doi.org/10.1007/s12103-012-9188-9

Morelock, J., Walther, J., & Sochacka, N. W. (2019, June). *Academic change from theory to practice: Examples from an engineering faculty development institution.* Paper presented at the 2019 American

Society for Engineering Education Annual Conference and Exposition, Tampa, FL. https://peer.asee.org/32022

Mumford, K., Hill, S., & Kieffer, L. (2017). Utilizing undergraduate research to enhance integrative learning. *Council on Undergraduate Research Quarterly*, *37*(4), 28–33.

Myers, J., Sawyer, A. G., Dredger, K., Barnes, S. K., & Wilson, R. (2018). Examining perspectives of faculty and students engaging in undergraduate research. *Journal of the Scholarship of Teaching and Learning*, *18*(1), 136–149. https://doi.org/10.14434/josotl.v18i1.22348

Nelson Laird, T., BrckaLorenz, A., Zilvinskis, J., & Lambert, A. (2014, November). *Exploring the effects of a HIP culture on campus: Measuring the relationship between the importance faculty place on high-impact practices and student participation in those practices.* Presentation to the Annual Meeting of the Association for the Study of Higher Education, Washington, DC.

Perrella, A., Dam, H., Martin, L., MacLachlan, J. C., & Fenton, N. (2020). Between culture and curricula: Exploring student and faculty experiences of undergraduate research and inquiry. *Teaching & Learning Inquiry*, *8*(2), 90–113.

Rogers, M., & McDowell, W. G. (2015). Assessing the impact of undergraduate research on graduation rates at the University of Georgia. *Council on Undergraduate Research Quarterly*, *36*(2), 33–38.

Santos, S. J., & Reigadas, E. T. (2004). Understanding the student-faculty mentoring process: Its effects on at-risk university students. *Journal of College Student Retention*, *6*, 337–357. https://doi.org/10.2190/KGVC-7218-DPER-RMBC

The Omidyar Group. (2019). *Systems practice: A practical approach to move from impossible to impact.* Toronto, Canada: Acumen Academy.

Wallace, D., Abel, R., & Ropers-Huilman, B. (2000). Clearing a path for success: Deconstructing borders through undergraduate mentoring. *The Review of Higher Education*, *24*(1), 87–102. https://doi.org/10.1007/s11162-012-9280-5

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.

Zimbardi, K., & Myatt, P. (2014). Embedding undergraduate research experiences within the curriculum: A cross-disciplinary study of the key characteristics guiding implementation. *Studies in Higher Education*, *39*(2), 233–250. https://doi.org/10.1080/03075079.2011.651448

Journal of the Scholarship of Teaching and Learning, Vol. 21, No. 1, April 2021, pp. 320-362.
doi: 10.14434/josotl.v21i1.30101

Creating More Inclusive Research Environments for Undergraduates

Heather Haeger
California State University, Monterey Bay
hhaeger@csumb.edu

Corin White
California State University, Monterey Bay

Shantel Martinez
California State University, Monterey Bay

Selena Velasquez
California State University, Monterey Bay

Abstract: Although there are numerous evidence-based benefits to undergraduate research for new-majority students (students who are from traditionally underrepresented ethnicities, first-generation college students, students from lower-income families, or transfer students) (Hurtado, S. et al., 2011; Kinzie et al., 2008a; Lopatto, 2007), they are less likely to participate or stay in mentored research experiences (Finley & McNair, 2013; Haeger et al., 2015). In order to determine not only who has access to undergraduate research, but to also identify what barriers to full-inclusion exist for new-majority students, we conducted a mixed methods study at a public, Hispanic Serving Institution. We analyzed institutional data to explore who participates in research and who does not. We also specifically sampled a group of students who expressed an interest in research experiences but who never actually participated for our student survey (N=96). Additionally, we conducted five focus groups with students, staff, and faculty (N~30). We found positive results in the analysis of patterns of participation and found no significant or substantial differences between students who did or did not participate in undergraduate research in terms of race/ethnicity, gender, or first-generation status. The undergraduate researcher population did have significantly more STEM majors and Pell grant recipients. The qualitative analysis identified barriers to participation in research in the following areas: access to research opportunities, programmatic structures, research culture and norms, and campus climate. We present these findings along with descriptions of initiatives that have been successful in diversifying research participation and strategies to create more inclusive research environments.

Keywords: inclusivity, undergraduate research, engagement, first-generation college students, traditionally underrepresented minority, new-majority, low-income

The increasing diversity of the U.S. population and population of students in higher education inspires a national call that highlights the need to focus on equity and inclusion in undergraduate research (UR) (National Academies of Sciences, Engineering and Medicine, 2017), both as a social justice issue and in order to prepare students for careers and graduate education, particularly in STEM (Estrada, Hernandez, & Shultz, 2018; National Math + Science, 2010). Undergraduate research, a well-established high-impact practice, provides significant benefits for new-majority students (students who are from traditionally underrepresented ethnicities, the first in their family to go to college, from lower-income families, and transfer students) (Jones, Barlow, & Villarejo, 2010; Kinzie, Gonyea, Shoup, & Kuh, 2008; Villarejo, Barlow, Kogan, Veazey, & Sweeney, 2008). However, new-majority students are less likely to participate in UR than their peers (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2011), even when attending Minority Serving Institutions (MSI) (Haeger, BrckaLorenz, & Webber, 2015). Additionally, when participating in research, new-majority students may find a research culture that is an unsupportive or hostile environment (Clancy, Nelson, Rutherford, & Hinde, 2014).

To explore who has access to research opportunities and to identify potential barriers to participation for new-majority students, we conducted a mixed-methods study at a public, primarily undergraduate, Hispanic Serving Institution (HSI). The diverse student body and established research programs provide an opportunity to contribute to the literature on undergraduate research, which is dominated by studies at Predominantly White Institutions (PWI). As of Fall 2020, the institution had a population of 7,616 students comprised of 62% women, 38% men, and less than .01% non-binary students (CSUMB IAR, 2019). More than half the student population is an underrepresented minority (URM): 44% Latino/a, 8% two or more races, 4% African American, 1% Native American, and 1% Pacific Islander (CSUMB IAR, 2019). In addition, 51% of students were the first in their family to go to college, and 32% were low-income (Pell Grant eligible) (CSUMB IAR, 2019). The institution also has a centralized undergraduate research office—the Undergraduate Research Opportunities Center (UROC)—which supports (financially and professionally through its multiple programs) undergraduates of all disciplines and at various stages of the research process.

Our mixed-methods study utilized institutional data, surveys, and focus groups to address the following research questions:

1. **Representation:** How does the demographic and disciplinary background of undergraduate researchers reflect or differ from the general student population and from other students who are interested in research but do not actually participate?
2. **Inclusivity:** What are the programmatic, cultural, and environmental barriers to new-majority student participation in research as identified by students, faculty, and staff?

This article will answer these questions and will discuss the implications of this research using an interactional model of inclusivity. We also present responses/strategies to move towards full inclusion in UR.

Conceptual Framework

We conceptualize inclusivity as a continuum instead of a dichotomous "inclusive" or "exclusive" environment while recognizing that experiences of inclusivity are not monolithic. An environment which is inclusive and supportive for some students may be exclusive for others. Additionally, mesosystems within universities, such as policies, programs, and structures, interact to shape students' social interactions and sense of belonging (Kilanowski, 2017). Our research will examine how inclusive the environment is and to whom it is inclusive through an interactional model of social and environmental factors (Figure 1) adapted from BrckaLorenz, Duran, and Haeger (2020). In this model, we examine how university culture, structures, policies, and programs intersect and interact in order to create more inclusive or exclusive environments.[1]

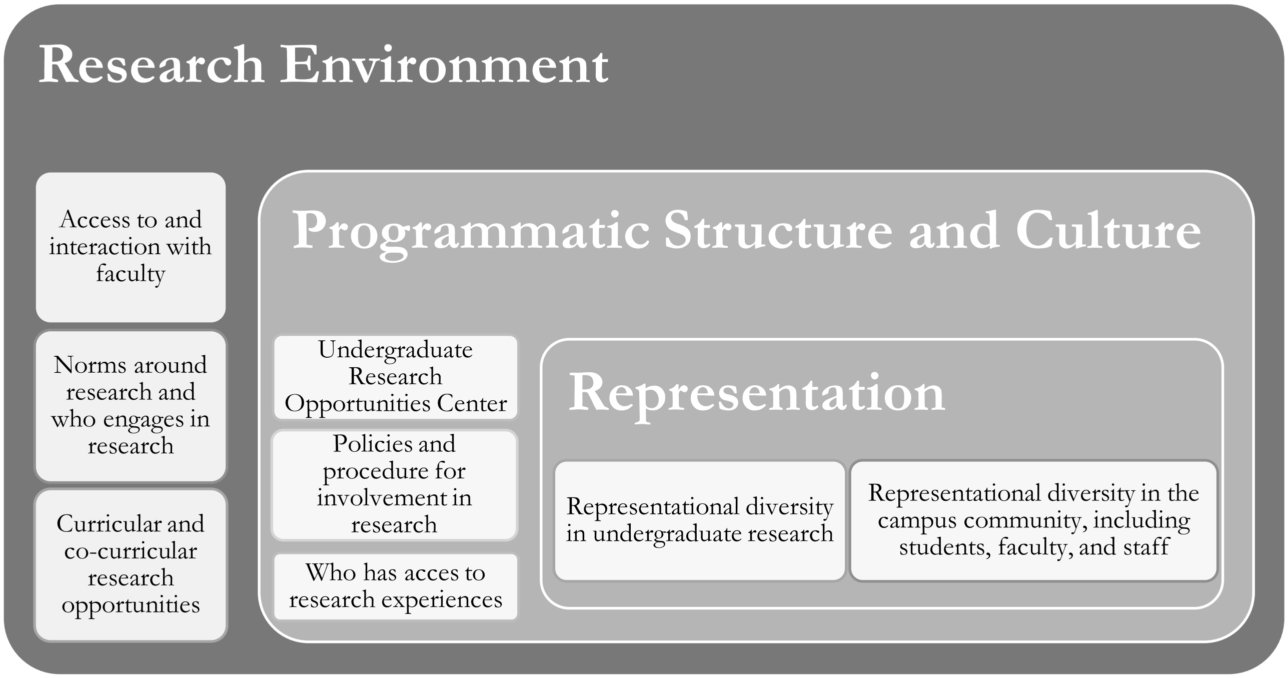

Figure 1: Conceptual Model of Inclusivity. Intersectional levels of inclusivity starting with representation, then programmatic structure and culture, both within the larger campus research environment.

Representation

The foundation of an inclusive environment is representation, meaning how representative is the population of researchers when compared to the student population. Issues of underrepresentation are a significant problem in UR (Haeger et al., 2015; Kinzie et al., 2008b) with significantly fewer students of color, first-generation, low-income, and transfer students participating in undergraduate research, even at Minority Serving Institutions. This is a critical equity gap in access to undergraduate research, but we also need to look beyond representation and examine inclusivity in terms of programmatic structures, research environments, and campus research culture.

[1] In this paper, the authors are encouraging a paradigmatic shift away from the term 'diversity' with regards to identifying and building more equitable opportunities for students engaging in undergraduate research. Rather, we offer the term, 'inclusion' in its place due to its move towards intersectionality (Crenshaw, 1991; Collins & Bilge, 2016) and belongingness. In line with other scholars, we critique the term 'diversity' as it often obscures systematic, historical, and oppressive power structures, while upholding marketplace values and neoliberal constructions of race, ethnicity, gender, sexuality, ability, citizenship, etc. As such, the term 'diversity' frequently is institutionally utilized to invoke 'difference', yet simultaneously blurs 'difference' and fails to evoke a commitment to action or change. For further literature, please see Ahmed, 2012; Alexander, 2005; Ali, 2009; Anzaldúa & Keating, 2009; Deem & Ozga, 1997; Mohanty, 2003; and Puwar, 2004.

Programs

Undergraduate research programs support retention (Sweeney & Villarejo, 2013), foster career development (Chang, Sharkness, Hurtado, & Newman, 2014), and develop self-efficacy (Robnett, Chemers, & Zurbriggen, 2015), but research has not examined how programmatic structures create or limit access to research. We examine representation on a campus that has taken numerous steps to increase inclusion in research, allowing us to understand if such programmatic interventions have increased student access. In addition, we advance the conversation by including qualitative data to give voice to students' experiences and gain insight into why they did or did not participate.

Research Environment

Historically, research is an exclusive environment (Milem, Chang, & Lising Antonio, 2005). Students have to be invited into research or granted access by someone in a position of power (e.g., faculty or graduate student), meaning that students are operating in relationships where they often have the least valued knowledge and perspective, least ownership or belonging to that space, and least powerful position in the relationship (Hurtado, Tran, & Chang, 2011). This social context is crucial to consider when understanding the context in which students gain access to research opportunities and how they navigate those experiences.

Methods

We conducted a multi-phased, mixed-methods study at a diverse 4-year, public institution from 2017-2019. The study was submitted to the Institutional Review Board (IRB) as protocol number 16-033. The IRB determined the study did not meet the federal definition of human subject research (Part 56 of the 21 Code of Federal Regulations and Part 46 of the 45 Code of Federal Regulations); therefore, the project does not require the Committee for the Protection of Human Subjects (CPHS) approval. This determination was made because the data was collected and analyzed as quality improvement activities to improve access to and support of undergraduate research and did not involve systematic testing of a new intervention (45 CFR 46.102(d)). Even though the study did not require CPHS approval, we have taken extra precautions to conduct this study ethically while protecting participant anonymity. We collected limited identifiers (consent forms) for survey and focus group participants, and the lead researcher permanently de-identified all data before analysis and before data was made available to other members of the research team. Researchers also completed the following CITI trainings: Humans Subjects in Research, Responsible Conduct of Research (Social Sciences), and Family Educational Rights and Privacy Act (FERPA).

The study was conducted in three phases (Figure 2). To examine representation as the first phase, we first identified students who had not participated in research, yet expressed interest in research (interested students). We operationalized "interest" as attending a meeting or workshop focused on finding research opportunities. Next, we cross-referenced this list of students with the list of students who participated in research through UROC to find the group of interested non-participators. Mean comparisons on institutional data were used to test the difference in representation between UR and interested students in terms of gender, race/ethnicity, Pell eligibility, parental education (first-generation in college), GPA, class standing, and major. We were able to identify 112 interested students (students who expressed an interest in research between September, 2016 and February, 2017 but who did not participate in research on campus).

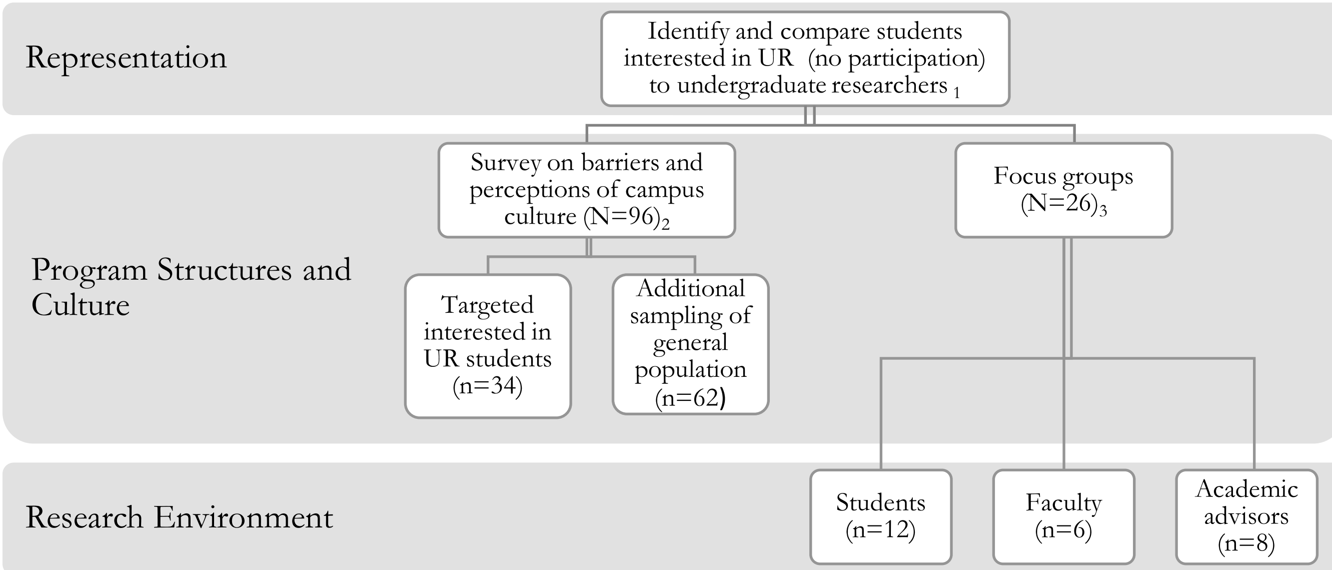

Figure 2: Data Collection within Intersectional Model of Inclusivity. Institutional data on representation. Survey and qualitative data on programmatic and research environment.

To create a comparison group, we identified students who did not participate in research despite expressing an interest in finding research opportunities. We operationalized interest in research as attending workshops about finding research opportunities or scheduling meetings with UROC staff to learn about research opportunities. Surveys were first targeted to these interested non-participators with a 30% response rate, but additional sampling from the general population was used to increase the sample and capture diverse student experiences.

To move beyond numerical representation, we also surveyed the 112 interested students with a 30% response rate. To increase the sample, we sent out an email to students who had signed up for information about research through the UROC email list, student clubs, and sports teams (N=96). The survey asked students about their knowledge of research opportunities, their educational and career aspirations, interaction with staff and faculty, and information channels on campus. Students were also asked questions about the norms and culture of research and barriers that might prevent participation in research.

The third phase of the research involved conducting focus groups with academic advisors, faculty, and students. All academic advisors on campus were invited to participate in the focus group, and 50% of them participated in one of the two focus groups for a total of eight participants. Faculty were recruited from a faculty working group on mentoring, which included many faculty who mentored students in research. All six faculty in the working group participated in the focus group. Since these faculty were actively engaged in thinking about how to better support and mentor students, they provided a key perspective on mentoring in research, and future research should consider sampling faculty who may be less engaged in research mentoring or who have specifically chosen not to mentor students to further understand barriers to participation in research. Participants for the student focus group were recruited by emailing the survey respondents and through fliers on campus. The majority of students in the focus groups had not participated in mentored research experiences or course-based research experiences. Students who responded to the flier and attended a focus group despite having participated in research were still included in the study and provided useful information about barriers they had to overcome in order to participate in research.

Focus group protocols were informed by previous literature and by issues that were brought up in the survey. All of the focus groups discussed questions about the definition of research, who participated in research, the availability of research opportunities on campus, and barriers for participation in research. Student focus groups discussed questions about direct experiences. Faculty and advisor focus groups discussed direct experiences in mentoring students in research or helping students find research opportunities and perceptions of barriers for students. Focus groups were transcribed and coded for emergent themes. Two researchers coded and created memos on each focus group. The research team met weekly to discuss the coding structure and to resolve any differences in interpretation. Themes were then organized and used to develop our conceptual framework for inclusivity (Figure 1).

Findings

The institution represents a unique sample because of the campus diversity and initiatives to increase inclusivity in undergraduate research. We have not tested the impact of any specific intervention, but instead have examined whether the summative impact of these systematic interventions increased inclusivity in research for undergraduates.

Representation

We found no significant or substantial differences between undergraduate researchers and students who did not participate in undergraduate research in terms of parental education or race/ethnicity (see Figures 3 and 4).

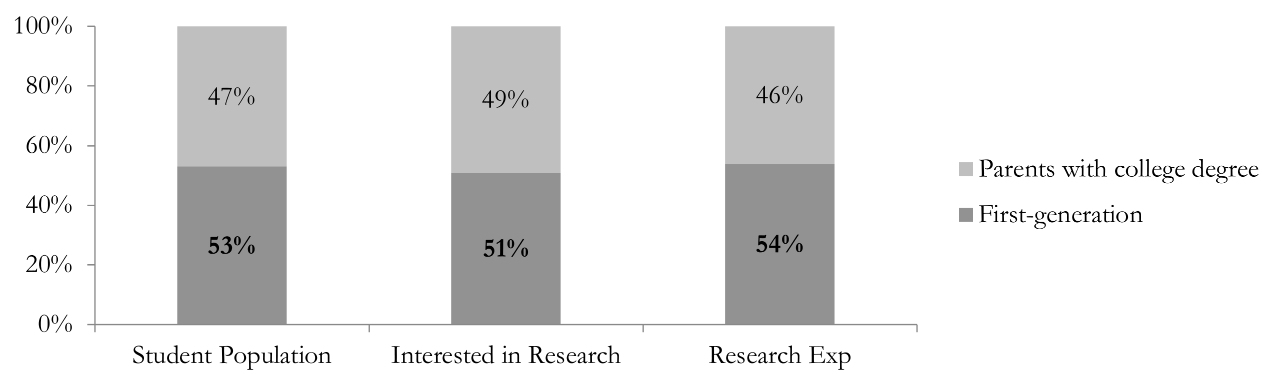

Figure 3: Comparison of Parental Education. Comparing proportion of first-generation undergraduate researchers to the general student population and students interested in research.

A significantly higher proportion of undergraduate researchers were from a low-income family (as measured by Pell Grant eligibility); 54% of undergraduate researchers were Pell-eligible compared to 38% of interested students and 36% of the general student population ($p<.001$, Figure 4).

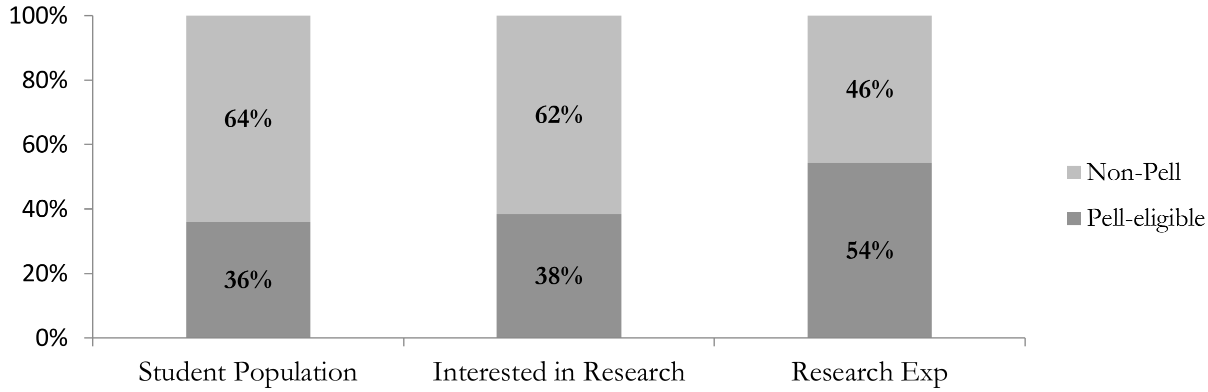

Figure 4: Comparison of Low-income/Pell-eligible Students. Comparing the proportion of Pell eligible undergraduate researchers to the general student population and interested-students.

The proportion of students of color in research (45% URM) is somewhat lower than interested students (54% URM) and the general student population (57% URM) (Figure 5).

Though national trends, even at other MSI's, suggested continued patterns of unequal participation in undergraduate research, we found that the population of undergraduate researchers was more diverse than the general student population in terms of income level and parental education, but slightly less diverse in terms of race. The majority of undergraduate researchers were the first in their family to go to college, Pell-eligible, and/or from a race/ethnicity traditionally underrepresented in higher education.

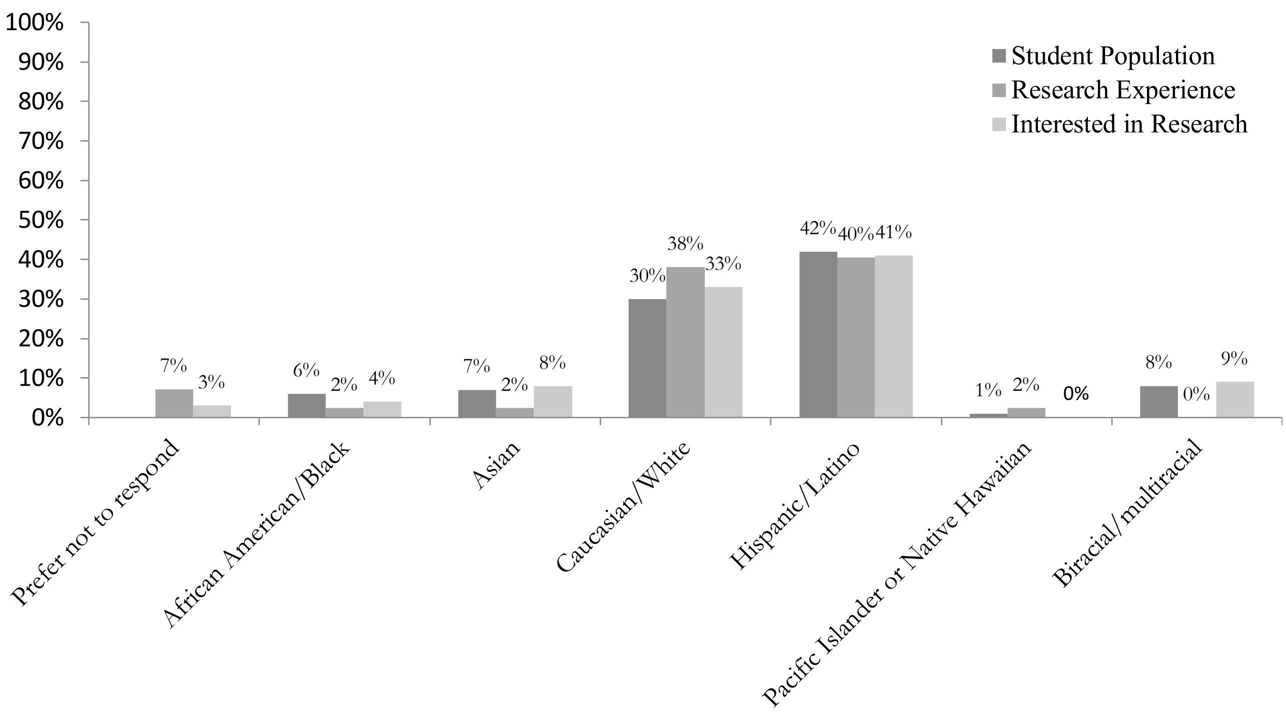

Figure 5: Comparison of Race/Ethnicity. Proportion of undergraduate researchers, general student population, and interested students by race/ethnicity.

Though the majority of undergraduate researchers were the first in their family to go to college, from lower-income households, and were students of color, this was not reflected in faculty and advisor perceptions. Faculty and advisors stated in the focus groups that they thought fewer first-generation college students knew about the value of research or how to get involved in research experiences. A science faculty noted: "First-gen students don't know what research is or why it's beneficial to them. Too esoteric to them" (*Faculty focus group).* Advisors also brought up concerns that the lack of diversity in faculty mentors would lead to fewer students of color participating in research:

> A student who is a first-generation, person of color and they don't see that representation, they are going to turn away. Then faculty also play a role in hindering a student's opportunity to really reach their full potential as someone who would want to be a researcher. So I think that inclusion is very important especially with the population of students that we have here, yeah diversity and inclusion. (*Advisor focus group).*

Similarly, students brought up how their background made getting involved in research more difficult, as this interested student wrote:

> I come from a family of Mexican immigrant (now citizens) laborers. They came here with nothing and without a proper education. We grew up in a low income status… so my options were limited. Knowing that I did not have any family in research let alone in college made that bridge to research even harder. For someone like me I have had to have had a lot of ambition, motivation and guts to get to where I am right now, but that is a lot easier said [than] done. (*Student survey).*

These sentiments from students, faculty, and staff illustrate the intersections of race and class, and that even when numerical representation is achieved, students can still experience barriers that make participating in research more difficult.

Programmatic Structure and Culture

The vast majority (76%) of students had heard about undergraduate research opportunities on campus, with the majority of students hearing about research through professors (72%) or from the UROC (68%) (Figure 6). "Other" responses included: emails, Equal Opportunity Program (EOP), flyers, and the university search engine.

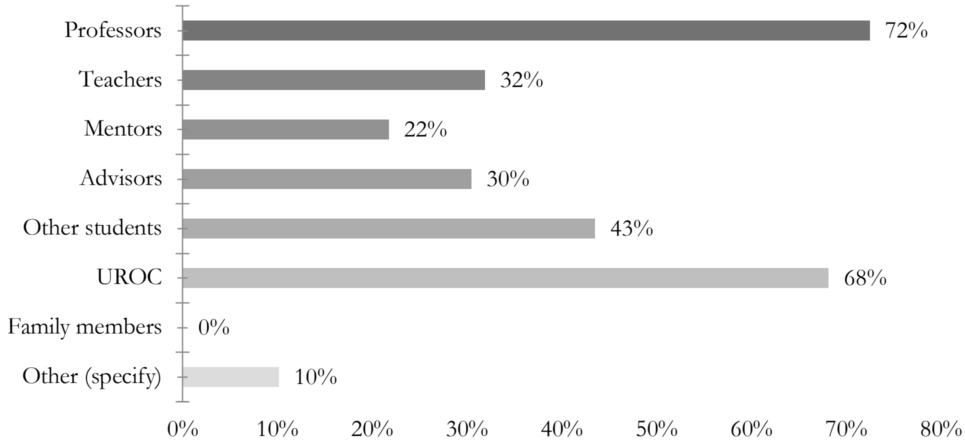

Figure 6: Information Channels. Students reporting where they learned about research opportunities.

A large majority of students believe that research would be helpful for their future goals (Figure 7). The fact that 94% of students think that UR would be or might be helpful for them, but that the majority do not participate in research, suggests a need to increase access to research opportunities.

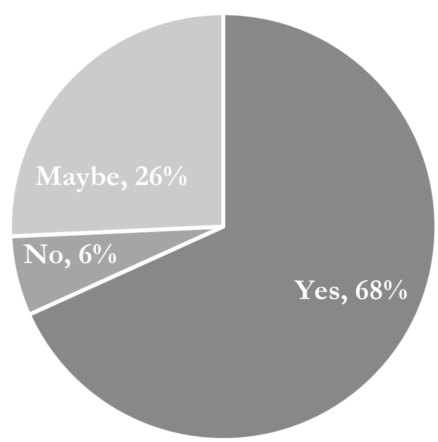

Figure 7: Would undergraduate research help you in your career goals? Students reporting if research would help them in their careers.

Some of the most common reasons for students not participating in research despite seeing it as valuable were logistical and related to confusing program structures and policies. Navigating academic structures, such as finding and applying for research opportunities, is confusing for students. The institution is unique in that many of the mentored research opportunities are funded (paid hourly); however, many students said that they could not afford to participate in research in terms of time or money and were unaware of paid research opportunities. Many students in the survey (51%) brought up economic barriers that prevented them from participating in research. Most explicitly, students discussed two economic barriers: difficulty in finding paid research opportunities and not having enough time to participate in unfunded research experiences because they had to work. This can be seen in a student's discussion of why they did not participate in research:

> A lot of these opportunities do not pay and a lot of students need money… Pay limits on how many hours a student can work also take away from the ability of students to provide for themselves, forcing them to choose other jobs. (*Student survey).*

Students also noted that taking care of family members and long commute times made it more challenging to participate in research.

Another significant barrier was finding a faculty mentor. Structural barriers, such as not taking classes in their major the first couple years of college or being a transfer student, meant that many students did not interact with tenure track faculty in their major until they were upper-division students, which made finding research opportunities before they graduated difficult. We found that the majority (61%) of interested students were seniors and that an additional 29% were juniors when they expressed interest in research. Interested students had completed an average of 95 units (with an additional 15 units in progress), so limited time left in their undergraduate career may have influenced why they did not participate in research. A student noted that students may not have access to tenure track faculty in their discipline until they are in upper division courses:

> It seems, you need to know someone in order to participate in the research. My challenge is [I] needed a science mentor when I haven't started my science course yet. So I feel behind the curve because I plan to take those science courses my final semester which wouldn't allow enough time for me to gain a mentor/relationship with a professor in order to be mentored through research. *(Student survey response).*

The underrepresentation of lower-division and recent transfer students is also related to university structures that affect when students are able to take classes and connect with tenure track faculty in their major.

The challenge of connecting with faculty in their discipline before they were in their last semester or two was even more pronounced for transfer students. An upper-division transfer student in the focus group stated that research "is not accessible to me as a transfer [student]; as soon as you step on campus you have to apply to UROC" *(Student survey).* Even when students had engaged in research at their community college, they found it difficult to participate in research after transferring to a four-year institution, as this student discusses:

> There are students like myself who have been heavily involved with research at their community college and are transferring with the hope of doing more things like that … Being a transfer student made taking advantage of [a research] opportunity very difficult as well as being a financially independent student working two jobs. I was unable to plan for this opportunity when I transferred because my focus had to be on acquiring work. When transferring, I didn't know this [paid research] was an option. *(Student survey).*

Furthermore, approaching faculty about their research or available research opportunities was intimidating for students at all levels. One student who was not able to participate in research, despite wanting to, explained why the current system did not "work out" for her:

> I did not know how to ask for research. I did not know what it was. I knew I wanted to start participating in Research, but I feel like prior exposure or volunteering in projects would help fill that gap for students like myself. Maybe collaborating with professors who are on campus looking for students to participate on their projects would help students know what research is and create that bridge to undergraduate research. I know there are professors who could use help from undergraduates and I know they do not really do outreach at least not with UROC from what I remember. Collaborating with professors on these types of projects would better increase student participation in research at [the university] and help it be more diverse as well. *(Student survey).*

Many students expressed an interest in a centralized listing of research opportunities or even of faculty research interests. Even though many faculty list prior research and current projects in their profiles, students found this system difficult to navigate and felt too intimidated to email faculty they did not know. Students repeatedly asked for a centralized place to look for open research projects or information about faculty who are willing to work with undergraduate researchers. Students were also interested in opportunities to interact with faculty or resources on how to talk to faculty about research.

Research Environment

Approximately 25% of the student respondents discussed barriers related to research as an exclusive environment. Students felt that UROC and faculty research centers/labs were intimidating spaces where they did not belong:

> Although UROC is an amazing program I would love to see it become better. From a personal experience the current system feels like it is catered more to students who do have the privilege of coming from some sort of scientific background and I think this program could do better to introduce research experiences to students who do not come from that background. *(Student survey).*

This student further clarified that the "scientific background" they were referring to included having family or other role models who had gone to college or been involved in research before.

Similarly, many students stated that research was not for them and/or that research was only for students who "had it all together." This idea of students who "had it all together" was often conceptualized as students who were in STEM majors, had high GPAs, and/or had solidified their academic and career goals. One survey respondent stated that she thought the main reason more students didn't participate in research was "The mindset that only straight-A students will be successful at research" *(Student survey).* Undergraduate researchers did have slightly higher GPAs than interested students (3.4 UR vs. 3.2 interested-students), although the actual difference (0.2 points) was much smaller than the difference perceived by students. Faculty and advisors similarly thought that many students did not feel like they belonged in research because they did not see themselves as competent enough to engage in research.

The idea of who belonged in research and who should participate in research came up frequently, especially related to which disciplines offered research experiences for undergraduates and what type of student participates. There was not a significant disciplinary difference between researchers and interested students, but both interested students and researchers had a much higher proportion of STEM majors ($p<.001$). The majority of both undergraduate researchers (64%) and interested students (72%) were in STEM majors compared to only 21% of the general student population. Students also expressed the perception that research and UROC programs were intended for high-achieving STEM students. As one student stated:

> [Information about research] didn't apply to me. If you are not a science or STEM major, ...UROC is STEM oriented. In the World Languages buildings and Humanities buildings there are no representations of UROC. *(Student focus group).*

Similarly, when we asked faculty about who participated in undergraduate research on campus, they noted "social sciences and humanities [students] don't see how they fit in UROC. Think it doesn't really apply to them" *(Faculty focus group)*. Students also brought up broader ideas about social or cultural inclusion in research. When asked who typically participates in research, this student responded:

> At first, I always thought a lot of socially awkward people in white lab coats. When I interned at Adobe's research lab for my internship during Summer 2017, it changed my perspective of what PhD computer scientists do. It just feels like a very advanced school project that they have a lot of choice in deciding what to work on. I made friends and had a fun summer. *(Student survey).*

Students, faculty, and advisors all brought up the idea that students who already had clear educational or professional goals were more likely to participate in research than students who were still deciding on a major or career path. One student who mentioned that the idea of participating in research was too intimidating for him also described "typical" undergraduate researchers as "Highly motivated students who are on a path to graduate school" *(Student survey)*. In congruence, undergraduate researchers did report higher educational aspirations than non-researchers, and significantly more researchers aspired to go to graduate school ($p<.001$) (Figure 8). The vast majority (82%) of undergraduate researchers aspire to go to graduate school, with 52% aspiring to earn a doctorate degree. In contrast, 52% of students who had not conducted research aspired to go to graduate school, and only 23% aspired to a doctorate. Additionally, 23% of the non-researchers were undecided about their educational aspirations compared to only 7% of undergraduate researchers.

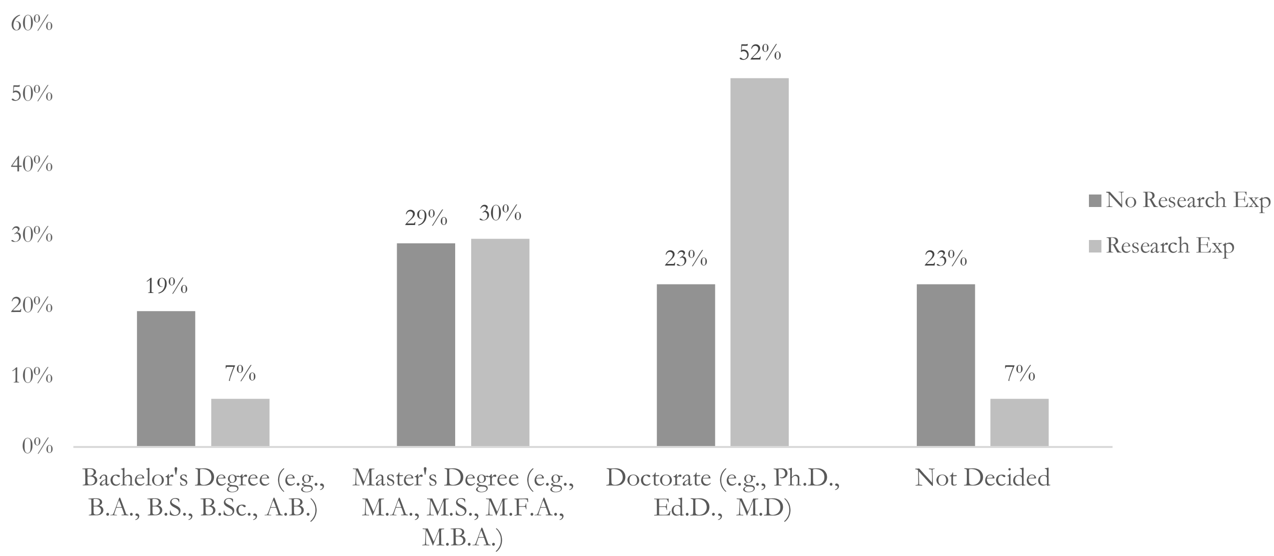

Figure 8: Educational Aspirations. Comparison between highest degree aspired to for undergraduate researchers and students without research experience.

As some of the students pointed out, it may be that students who have higher aspirations seek out research, but faculty also brought up that research helps students refine their educational aspirations.

Discussion

We have conducted a mixed-methods study in order to explore UR representation and UR inclusivity for new majority students at a diverse and predominantly undergraduate institution. In this section, we will discuss the implications of our findings and highlight responses UROC and others have implemented in order to address the identified barriers. The discussion and responses are organized within our conceptual framework (Figure 9) in order to strategize intervention, increase representation, evaluate program structure and culture, and, ultimately, create more inclusive research environments for undergraduates.

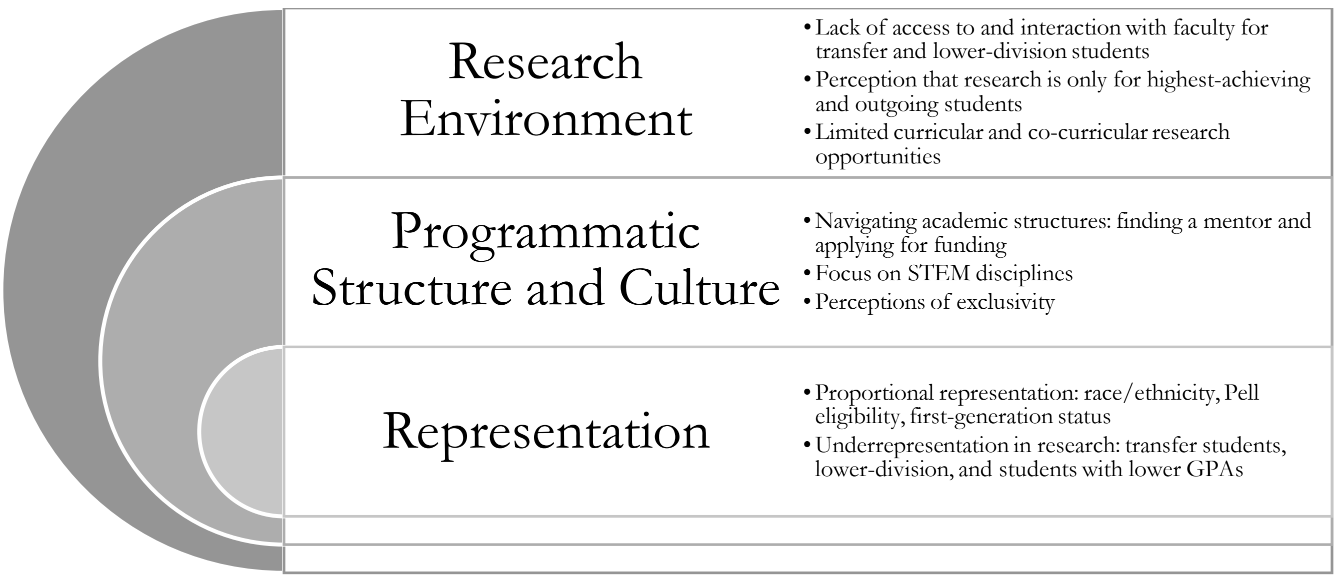

Figure 9: Findings within the Conceptual Model of Inclusivity

Representation

Our findings suggest that the basic level of representational diversity is met as the population of researchers was proportionally similar to the campus population and to students who expressed interest in research but did not participate. This is likely due to outreach efforts and the financial support provided by grant initiatives aimed at increasing diversity in research. These Department of Education grants (e.g., the Ronald E. McNair Postbaccalaureate Achievement Program and Hispanic Serving Institution, STEM Articulation Program) are used to provide funding for undergraduate researchers, fund outreach to traditionally underrepresented populations, and fund academic positions that support students in finding research placements and facilitate professional development. These programs, along with a campus commitment to diversity, have worked to break patterns of unequal participation in research in terms of race and class (Haeger, BrckaLorenz, & Webber, 2015). Despite the success of these efforts, transfer students were still less likely to engage in research, and a significant population of students believe that research would benefit them in their education and career goals but are not able to participate. These findings point to the need for the creation of more opportunities and stronger outreach to lower-division, community college, and recent transfer students.

Representation Response: Community College Apprentice Research Experience (CCARE). The community college apprenticeship program was created in 2018 in order to provide an opportunity for community college students to connect with the campus community and conduct research with university faculty before transferring. Through outreach and collaboration with local and statewide community colleges, we aim to recruit incoming transfer students and students who intend to transfer to a 4-year college. Once selected, students participate in a 9-10 week research experience, are connected with appropriate university resources (e.g., staff at the Transfer Student Success Center), and are highly encouraged to live with their cohort of CCARE students on campus. The summer concludes with a summer research symposium where all undergraduate researchers present their findings. In 2019, this symposium included 25 oral presentations and over 80 posters from students conducting research at the university and regional research partners.

Representation Response: Course-based Undergraduate Research Experiences (CURE). CUREs are often touted as a way to increase opportunities for students to engage in research (Nikolova, Eddins, & Williams, 1997; Wilson, Howitt, & Higgins, 2015). The creation of CUREs targeting recent transfer students and lower-division students would provide earlier contact with tenure-track faculty, as well as an introductory research experience for more students. A book titled "Course-based Undergraduate Research Educational Equity and High-Impact Practice" outlines several initiatives that target students in lower division courses (Hensel, 2018). For example, faculty at North Seattle College (NSC) and Central Washington University have collaborated to develop Interdisciplinary Investigation (IDI)-Lab for first-year community college students with an emphasis on investigative skills. In their chapter titled "A High-throughput model for CUREs for the first two years of Chemistry and Biology," the authors discuss the creation of IDI-Lab and report student self-assessed gains (e.g., an increased confidence in science communication) as determined via the CURE survey (Lopatto 2004). We have created a CURE Faculty Fellows Program in order to support faculty to develop courses that engage students in authentic research experiences. This program is currently in its third year and is funded by the Provost and a U.S. Department of Education Hispanic-Serving Institution: STEM Articulation Grant. Like the creators of IDI-Lab, our goal is to engage students in collaborative, authentic research experiences and to encourage the integration of CUREs across departments. In order to support faculty in developing course-based research experiences, the CURE Faculty Fellows programs provides up to $5,760 for 72 hours of work (based on summer salary rate) provided by a Department of Education Hispanic-Serving Institution (HSI) Division grant and an institutional commitment through the Provost's Office. During this funded time, faculty work together in a community of practice to develop new courses or redesign existing courses to include research experiences. In addition to providing time for course development, campuses should consider how else to incentivize the inclusion of research in courses, including how it is documented and evaluated in tenure and promotion consideration.

Program Structure and Culture

Looking beyond representation, we found a number of barriers to full inclusion in research. At the programmatic level, navigating academic structures, like applying for funding through UROC or finding a research placement with faculty on campus, were significant barriers to many students. Students requested a centralized way to learn about research happening on campus instead of having to email individual faculty or only having access to faculty that they currently had classes with. Students also wanted explicit and clear information about the availability of funding for research and the application process. Furthermore, even though the university offers a number of funded opportunities, many students are unaware of them. Students also felt that UROC and research in general were intimidating, exclusive spaces.

Program Structure and Culture Response: Scholar Spotlights. UROC is collaborating with Dr. Corin Slown, Assistant Professor in the College of Science, to integrate "Scientist Spotlights" in several lower-division STEM courses. "Scientist Spotlights" are metacognitive homework assignments that highlight counter-stereotypical scientists. Schinske et. al. (2017) demonstrated that students who completed these spotlights found personal connections with the highlighted scientists and described scientists with counter-stereotypical attributes. These data were exceptionally encouraging because these students were enrolled in an introductory biology course at a diverse community college (De Anza College).

Research Environment

The perception of exclusivity was a barrier for research with the UROC and in general. Faculty also mentioned that inviting students into research has inherent bias. For example, faculty reaching out to students in class about participating in research likely favors students who are more outgoing, who resemble or are otherwise more relatable to faculty, and who participate more actively in class (Aikens et al., 2016; Haeger & Fresquez, 2016). Thus, students whose cultures show respect by listening quietly and attentively may be frequently overlooked, and faculty may not realize the implicit biases affecting the students. Students also frequently talked about research only being for the highest-achieving students and for students with concrete academic and career plans. Thus, students that did not think their GPAs were strong enough and/or that lacked clear goals opted out of research. Shifting the norms about who does research and emphasizing that exploration and failure are part of the research process can help shift this expectation.

Research Environment Response: The Game of Undergraduate Research. Games such as "Fair Play" (Guitierrez et al., 2014) and "REAL LIVES" (Bachen, Hernandez-Ramos, & Raphael, 2012) have been used to foster empathy by allowing players to inhabit the lives of other individuals. The creators of "Fair Play" show a reduced implicit race bias in players that had high empathy for Jamal, a black graduate student (Guitierrez et al., 2014). We have developed "The Game of Undergraduate Research" (see Appendix I) in order to share research findings from the present study with faculty regarding the barriers to participation in UR or their CUREs. This faculty development activity is an adaptation of "The Game of Life", a board game where players read through scenarios and roll dice to see which outcome their character will experience. The characters were created from common demographic characteristics (e.g., being a first-generation college student or a student whose parents went to college) and situational barriers (e.g., having transportation issues, child care responsibilities, or long commutes). Both the UR and CURE version of the game have participants walk through scenarios in order to explore potential experiences of undergraduates. The CURE version of the game has been piloted in the first two iterations of a CURE Faculty Fellows Program, and the UR version was played by approximately 200 faculty and staff at national conferences and at the university. The CURE Faculty Fellows Program is facilitated yearly with small (10-15) cohorts of faculty by UROC staff and faculty partners. 75% of faculty in the 2019-2020 cohort said that their participation in the game moderately or significantly influenced their plans to develop their courses. We were also encouraged to see faculty processing how privilege can intersect with undergraduate research opportunities and CURE structures in their reflections. Many faculty were struck by how factors like socioeconomic status, transfer status, or being a parent/caretaker can "stack the deck" and create barriers for students; as one faculty noted, "People with different levels of privilege have different sized margins that allow success or failure. These margins are out of peoples' control" (*Faculty survey*). Another faculty reflected on the ways that intersecting identities and life circumstances can impact student experiences: "It became apparent that some students are very privileged and rarely experience negative results from 'Life.' The game reminded me to take student identity into consideration when setting up the CURE project" (*Faculty survey*). Instructions for facilitation and the game itself are available in Appendix I.

Conclusion

This research illustrates the ways that research environment, programmatic structure, and culture can influence inclusivity in research. Representational diversity is a crucial foundation, but even when equal representation is achieved, institutions should work to reduce barriers for new-majority students to move towards full inclusion in research. These barriers will be unique to each institution, and mixed-methods studies provide the qualitative and quantitative data needed to plan student voice and data-informed interventions. As we continue to scale-up undergraduate research experiences, it is crucial to critically evaluate not only who has access to research experiences, but also how inclusive these experiences are for new-majority students.

Acknowledgements

Research reported in this paper was supported by the Department of Education McNair Scholars Program under award number P031C160221 and the Department of Education Hispanic-Serving Institution (HSI) Division under award number P217A170213 through California State University, Monterey Bay's Undergraduate Research Opportunity Center.

Appendix

Appendix 1. The Game of Undergraduate Research.
Game Facilitation Notes

The game of UR is conducted in groups of four and requires one die per group. Each participant is handed a copy of the game and rolls the die to determine who will be Lucas, Christopher, Deborah, and Lissette. The participant who rolls the lowest number will facilitate the group and be the student named Lucas throughout the duration of the game. The game includes 5 challenges, and it is the facilitator's job to read each challenge and make sure each character rolls to determine their outcome. After each challenge, the outcome (-1 or +1) is recorded for each student identity. Each student identity has a different probability of success (e.g., Christopher is less likely to succeed than Lissette).

The participants usually need guidance within the first 10 minutes to ensure they are recording the outcomes of each student and understand how to determine said outcome. Once the participants are orientated, the game moves quickly. We suggest having participants pause to reflect after challenge 3 or 4. Reflection questions such as "How is Christopher doing?" and "How are you feeling as Lucas?" have helped participants discuss privilege and the inequities experienced by their students. Challenge 5 concludes the game, and participants are prompted to record and discuss final outcomes (e.g., grade in the CURE or acquiring an undergraduate research experience).

The final outcome is different for student identities that get less than two positive outcomes, at least two positive outcomes, or at least three positive outcomes. Usually, Lucas has the most success while Deborah has the least success, and participants with these characters have polarized emotions about their experiences. The reactions of the participants give the game facilitators the material needed to moderate a discussion about privilege, equity, and strategies to make UR or CUREs more equitable. If multiple groups of four play the game, it is interesting to record the outcomes of each student identity in each group and discuss the similarities and differences between how participants felt as each student.

Appendix 2. The Game of Mentored Undergraduate Research.

Overview: This game is designed to walk you through scenarios that allow the exploration of the potential student experience within undergraduate research. ***Your goal as a student is to obtain an undergraduate research experience and prepare for your future.***

The Facilitator: Roll to see who the facilitator is (lowest number is facilitator and Lucas). Assign student identities around the circle. Your job as the facilitator is to read each scenario/challenge.

Each student will roll and then read their outcome based on their roll.

Be sure to announce and record your outcome (facilitator: circle **+** for positive or **-** negative) to the group before moving to the next person.

Positive or Negative Outcomes

	Challenge 1: Finding Out About Research		**Challenge 2: Getting In**		**Challenge 3: Field Work**		**Challenge 4: Presenting your Research**		**Total Number of Positive Outcomes**
Lucas	+	-	+	-	+	-	+	-	
Christopher	+	-	+	-	+	-	+	-	
Deborah	+	-	+	-	+	-	+	-	
Lissette	+	-	+	-	+	-	+	-	

Student Identities

You are a student at Western University which is a medium sized public school with a centralized Undergraduate Research Opportunities Center (UROC).

Lucas is a White male from a middle-class family in New York. He is involved in intramural sports and a club on campus. He typically gets B's and C's. In order to get a positive result he **must roll a 1, 2, 3, 4, or 5.**

Christopher is an African American male, is from a low-income neighborhood in a rural area 25 miles from Western University. He lives at home and commutes to campus with a classmate. He marches in the school band and is an honor roll student. In order to get a positive outcome he must **only roll a 4 or 5.**

Deborah is an Asian American female. She is a single parent of two. She lives in an off-campus apartment 2 miles from Western University. She works two jobs and typically gets C's in school. In order to get a positive outcome she must **only roll a 6.**

Lissette is from a low-income family and is from Los Angeles, California. She is Latina and has undocumented parents. She is involved in many of the school organizations on campus and is typically a B student. In order to get a positive result she must roll **only a 2, 3, or 4.**

Challenge 1: Finding Out About Research Opportunities

You are thinking about what to do this summer and want to find an experience to build skills that will help you in your future career. You hear another student talking about doing research on campus over the summer. That sounds exciting to you but you don't know where to start. There are no more undergraduate research positions in the lab your friend works in and you feel a little discouraged about finding an opportunity.

What happens to your character? Roll the dice to find out.

Challenge 1: Finding Out About Research

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">You start by going to your professor's office hours. One of your instructors points out a bulletin board in the department where faculty list research positions. You apply for several summer research opportunities and get accepted to one.+ positive</td><td rowspan="3">You start by going to your professor's office hours and find out about several research opportunities on campus. They are all unpaid. You need to work fulltime over the summer to save money. The 50 mile commute and your summer job mean that you don't have time to do research. - negative</td><td rowspan="5">You are interested in participating, but, you only have time to do research on Saturday and Sunday mornings because that is the only time that you both have childcare and are not working. You cannot find a research opportunity that would fit in your schedule. - negative</td><td rowspan="3">You are interested in research and one of your professors is willing to mentor you, but your parents believe it would be a better use of your time to work or take summer classes. Your faculty mentor gives you some resources to share with your parents about how UR can help in your career goals which reassures your parents. + positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">You go to the UROC office and learn that you can get funding to do research this summer and stay in campus housing. You are able to find a mentor that is accepting students into his lab for the summer and you participate in the UROC Summer Research Symposium. + positive</td><td rowspan="3">You are interested in research and one of your professors is willing to mentor you, but your parents believe it would be a better use of your time to work or take summer classes. You currently help financially support your family and cannot afford to work fewer hours at your off- campus job. - negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>You start by going to your professor's office hours. None of them are accepting undergraduate researchers right now, so you do not do research this summer. - negative</td><td>You start by going to your professor's office hours and find out about several research opportunities on campus. They are all unpaid. You need to work fulltime over the summer to save money. The 50 mile commute and your summer job mean that you don't have time to do research. - negative</td><td>You talk to professors about your interest in research and they help you find a funded research opportunity so that you can quit one of your jobs and participate in research over the summer. + positive</td></tr>
</table>

Challenge 2: Getting In

It is the middle of the semester, and you are performing extremely well on all of your coursework in your favorite class. One day, your instructor announces that he is conducting research and looking for undergraduate researchers for the summer. He stated that he is looking for the *"best"* students to join his research team. This is of extreme interest to you; however, you have no experience in research.

What happens to your character? Roll the dice to find out.

Challenge 2: Getting In

<table>
<tr><th>Dice
Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">The professor personally comes to you and says that he has noticed how engaged you are in class and that you would be a great fit for his research team. This boosts your confidence and you apply. + positive</td><td rowspan="3">You are very interested in the opportunity, but you meet some of the other students in the lab. You do not connect with them, you do not want to be the only student of color in the lab, and you have never conducted research before, so you do not sign up. - negative</td><td rowspan="5">You are interested in participating, but do not think the professor would want to work with you because of your lower GPA. You are nervous about talking about your lower grades in other classes, so you do not sign up for the research opportunity.

- negative</td><td rowspan="3">Research sounds like an exciting way to engage in your studies, but you worry that

you are not one of the “best” in the class. You go to office hours and ask the professor what he is looking for. He describes the qualities he looks for and tells you that you would be a great fit! You apply. + positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">The professor personally comes to you and says that he has noticed how engaged you are in class and that you would be a great fit for his research team. This boosts your confidence and you apply. + positive</td><td rowspan="3">Research sounds like an exciting way to engage in your studies, but you worry that

you are not one of the “best” in the class, so you do not apply. - negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>Despite your professor suggesting you apply, you don’t have the time to balance school and sports with an outside lab opportunity, so you do not sign up. - negative</td><td>You are very interested in the opportunity, but you meet some of the other students in the lab. You do not connect with them, you do not want to be the only student of color in the lab, and you have never conducted research before, so you do not sign up. - negative</td><td>You talk to the professor about your interest in research and they tell you that this is a funded position with a flexible schedule so you apply to be on his research team. + positive</td></tr>
</table>

Challenge 3: Field Work

You are in a course-based undergraduate research experience. You and your fellow classmates have already gone through a boot camp that highlighted and taught you some relevant basic research skills. You and your classmates are excited and are surprised that people actually do research in your field. Your instructor announces that you all will be meeting on Friday mornings, off-campus, in a nature reserve 15 miles from campus to gather data for a group research project. This project counts towards two thirds of your final grade. You have never been to the location and are uneasy about how you will get there.

What happens to your character? Roll the dice to find out.

Challenge 3: Field Work

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1,2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">You have a car that was given to you as a graduation gift. You take yourself as well as your group members. You and your group collect all of the data needed for the assignment; and, you turn in your report and receive an A. + positive</td><td rowspan="3">You are not well connected with your peers in class so you ask your roommate who agrees to drive you to the field site. However, she cancels the morning of, and there are no public transportation routes. Therefore, you do not get credit for the assignment. - negative</td><td rowspan="5">You do not have a car and consider taking an Uber, but cannot afford it. You are unable to get to the site and collect data with your group. You do not know anyone else in the class, so you cannot find anyone to ride with. You fail the assignment. - negative</td><td rowspan="3">You have to work during the hours of the off campus assignment. Luckily, you are able to find someone to cover your shifts most of the days and carpool with a groupmate. You collect most of the data necessary to complete the assignment.. You all receive a B. + positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">You are not well connected with your peers in this class, but reach out to your group. They invite you to carpool to the data collection site. You are able to collect all the data needed to complete the assignment. You and our group receive an A. + positive</td><td rowspan="3">You have to work during the hours of the off campus assignment; and cannot find someone to cover your shifts. You are unable to meet your group at the data collection site and unable to do the assignment. Therefore, you fail the assignment. - negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>You have a car that was given to you as a graduation gift, but one Friday your car will not start. You do not make it to the data collection site that day, but do on all the other Fridays. You and your group receive a B. - negative</td><td>You are not well connected with your peers in class so you ask your roommate who agrees to drive you to the field site. However, she cancels the morning of, and there are no public transportation routes. Therefore, you do not get credit for the assignment. - negative</td><td>Your roommate gives you $30 to take a Lyft to the data collection site the first week, and you find someone you can carpool with the other weeks. You and your group submit your assignment and receive a B. + positive</td></tr>
</table>

Challenge 4: Presenting your Research

You are in a capstone/ senior level course-based research experience. Your instructor announces that the final will be a presentation at a conference in your field which is being hosted on your campus this year. Your group has the opportunity to present a poster at the conference. The symposium organizers are giving out awards for the best presentations and the instructor has agreed to award 5% points on top of the final grade of award winners. You are right on the edge between letter grades are excited to showcase what you and your group have accomplished. You are excited about this professional opportunity but also nervous because you have never been to a professional conference or given a research poster presentation before.

What happens to your character? Roll the dice to find out.

Challenge 4: Presenting your Research

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">This is your first research presentation; but members of your family have done research presentations before, so you know what to expect. You and your group work really hard and receive 2nd place. + positive</td><td rowspan="3">When you go to register for the conference, you realize you cannot afford the $150 conference registration fee. You do not register and do not present your research. - negative</td><td rowspan="5">The schedule from your two jobs makes meeting with your group difficult. You all work independently and meet together once. The day of the presentation no one is prepared but you. You and your group do not receive an award. - negative</td><td rowspan="3">You practice frequently with one another and feel confident in your ability to deliver. You print your poster through UROC. You and your group receive 1st place.

+ positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">When you go to register for the conference, you realize you cannot afford the $150 conference registration fee. A travel scholarship your instructor told you about helps you pay for the conference registration. You receive first place. + positive</td><td rowspan="3">You practice frequently with one another and feel confident in your ability to deliver. You volunteered to print your poster, but did not understand what that meant. You cannot afford to print it at the campus copy shop and do not know where else to go. Instead, you print out parts of your poster on regular pieces of paper and tack them up together. You and your group do not receive an award. - negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>This is your first research presentation but members of your family have done research presentations before so you know what to expect. Therefore, you do not work as hard with your group and do not meet as often as you should. You do not place. - negative</td><td>When you go to register for the conference, you realize you cannot afford the $150 conference registration fee. You do not register and do not present your research. - negative</td><td>The schedule from your two jobs makes meeting with your group difficult, but your group meets on Saturday mornings on Skype to plan and practice the presentation. Presentation day you deliver and receive 3rd place. + positive</td></tr>
</table>

Summary of Outcomes

Characters with less than 2 positive outcomes: You have no interest in pursuing undergraduate research. In fact, you are not sure what research looks like and why people do research. Furthermore, you feel that research is not for people like you.

Characters with at least 2 positive outcomes: You participate in an undergraduate research opportunity but have no interest in continuing to pursue it. You feel that only extremely intelligent people are able to do research, and doubt that you are one of those people.

Characters with at least 3 positive outcomes: You plan to pursue other research opportunities on campus and are exploring careers related to your research interests. There are so many opportunities in your field and you cannot wait to contribute; you sign up for research opportunities within your field of study.

The Game of Course-based Undergraduate Research Experiences

Overview: This game is designed to walk you through scenarios that allow the exploration of the potential student experience within undergraduate research. ***Your goal as a student is to obtain a strong grade in your class, participate in an undergraduate research experience, and prepare for your future.***

The Facilitator: Roll to see who the facilitator is (lowest number is facilitator and Lucas). Assign student identities around the circle. Your job as the facilitator is to read each scenario/challenge.

Each student will roll and then read their outcome based on their roll.

Be sure to announce and record your outcome (facilitator: circle **+** for positive or **-** negative) to the group before moving to the next person.

Positive or Negative Outcomes

	Challenge 1: Field Work		**Challenge 2: Group Work**		**Challenge 3: Unexpected Results**		**Challenge 4: Continuing Research**		**Challenge 5: Presenting your Research**		**Total Number of Positive Outcomes**
Lucas	+	-	+	-	+	-	+	-	+	-	
Christopher	+	-	+	-	+	-	+	-	+	-	
Deborah	+	-	+	-	+	-	+	-	+	-	
Lissette	+	-	+	-	+	-	+	-	+	-	

Student Identities

You are a student at Western University which is a medium sized public school with a centralized Undergraduate Research Opportunities Center (UROC).

Lucas is a White male from a middle-class family in New York. He is involved in intramural sports and a club on campus. He typically gets B's and C's. In order to get a positive result he **must roll a 1, 2, 3, 4, or 5.**

Christopher is an African American male, is from a low-income neighborhood in a rural area 25 miles from Western University. He lives at home and commutes to campus with a classmate. He marches in the school band and is an honor roll student. In order to get a positive outcome he must **only roll a 4 or 5.**

Deborah is an Asian American female. She is a single parent of two. She lives in an off-campus apartment 2 miles from Western University. She works two jobs and typically gets C's in school. In order to get a positive outcome she must **only roll a 6.**

Lissette is from a low-income family and is from Los Angeles, California. She is Latina and has undocumented parents. She is involved in many of the school organizations on campus and is typically a B student. In order to get a positive result she must roll **only a 2, 3, or 4.**

Challenge 1: Field Work

You are in a course-based undergraduate research experience. You and your fellow classmates have already gone through a boot camp that highlighted and taught you some relevant basic research skills. You and your classmates are excited and are surprised that people actually do research in your field.

Your instructor announces that you all will be meeting on Friday mornings, off-campus, in a nature reserve 15 miles from campus to gather data for a group research project. This project counts towards a third of your final grade. You have never been to the location and are uneasy about how you will get there.

What happens to your character? Roll the dice to find out.

Challenge 1: Field Work

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1,2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">You have a car that was given to you as a graduation gift. You take yourself as well as your group members. You and your group collect all of the data needed for the assignment; and, you turn in your report and receive an A. +positive</td><td rowspan="3">You are not well connected with your peers in class so you ask your roommate who agrees to drive you to the field site. However, she cancels the morning of, and there are no public transportation routes. Therefore, you do not get credit for the assignment. - negative</td><td rowspan="5">You do not have a car and consider taking an Uber, but cannot afford it. You are unable to get to the site and collect data with your group. You do not know anyone else in the class, so you cannot find anyone to ride with. You fail the assignment. - negative</td><td rowspan="3">You have to work during the hours of the off campus assignment. Luckily, you are able to find someone to cover your shifts most of the days and carpool with a groupmate. You collect most of the data necessary to complete the assignment. You all receive a B. +positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">You are not well connected with your peers in this class, but reach out to your group. They invite you to carpool to the data collection site. You are able to collect all the data needed to complete the assignment. You and our group receive an A. +positive</td><td rowspan="3">You have to work during the hours of the off campus assignment; and cannot find someone to cover your shifts. You are unable to meet your group at the data collection site and unable to do the assignment. Therefore, you fail the assignment. - negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>You have a car that was given to you as a graduation gift, but you run out of gas and do not have your wallet on you. You do not make it to the data collection site that day, but do on all the other Fridays. You and your group receive a B. - negative</td><td>You are not well connected with your peers in class so you ask your roommate who agrees to drive you to the field site. However, she cancels the morning of, and there are no public transportation routes. Therefore, you do not get credit for the assignment. - negative</td><td>You borrow $30 to take a Lyft to the data collection site the first week, and you find someone you can carpool with the other weeks. You and your group submit your assignment and receive a B. +positive</td></tr>
</table>

Challenge 2: Group Work

It is the middle of the semester and your group has a lot of data to analyze before the midterm. Your instructor informs you that there will be questions on the midterms that involve interpreting results and you need to meet with your group to practice. The group decides that the best time to meet is outside of class. Your group will also submit your group progress report at the end of this meeting.

What happens to your character? Roll the dice to find out.

Challenge 2: Group Work

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">You attend the group meeting and submit your group report. You also get an A+ on the midterm because you also attend weekly study groups.

+ positive</td><td rowspan="3">You don’t have a ride to campus outside of your normal class times. You miss the group meeting and you do not get credit for the group report. You also get a C- on the midterm because you did not benefit from participating in the study group. - negative</td><td rowspan="5">You do not have childcare outside of your normal class time, so you miss the group meeting and you do not get credit for the group report. You also get a C- on the midterm because you did not benefit from participating in the study group.

- negative</td><td rowspan="3">You are employed as an undergraduate researcher, and your hours are flexible. You are able to schedule your work around your group meeting.

You attend the group meeting and submit your group report. You also get an A+ on the midterm because you are familiar with the research process and lead several study groups. + positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">You do not have a ride and have to take a series of busses to get to campus which takes 3 hours each way. You attend the group meeting and submit your group report, but cannot attend any study groups. You get a B- on the midterm because you are so tired.

+ positive</td><td rowspan="3">The group is meeting during your work hours. Your family relies on your income, and you cannot afford to work fewer hours. You miss the group meeting and you do not get credit for the group report.

You also get a C- on the midterm because you did not benefit from participating in the study group. - negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>The group is meeting during an intramural game. You miss the group meeting and you do not get credit for the group report. You also get a C- on the midterm because you did not benefit from participating in the study group. - negative</td><td>You don’t have a ride to campus outside of your normal class times. You miss the group meeting and you do not get credit for the group report. You also get a C- on the midterm because you did not benefit from participating in the study group. - negative</td><td>You don’t have childcare, and bring your children to the meeting. It’s hard to focus or participate. You submit your group report. You also get a B- on the midterm because you were distracted during the study group.

+ positive</td></tr>
</table>

Challenge 3: Unexpected Results

You and your group have just completed the third iteration of a key experiment in your class, and you have some unexpected results that do not align with your prediction. Your instructor said that your results need to be repeatable and only two of the iterations match in terms of overall conclusion. Your group does not have the time to repeat the experiment before the final lab report is due.

What happens to your character? Roll the dice to find out.

Challenge 3: Unexpected Results

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">Your group talks to the instructor about your conflicting results. The instructor reiterates that negative results are still results and suggests that you include all of the results in your final lab report. The instructor also discusses the results with the group and they include an explanation of why the results conflict. The instructor is impressed with the thoroughness of the lab report and you receive an A+.

+ positive</td><td rowspan="3">Your group submits the report without addressing the differences in results and receives a B-.

- negative</td><td rowspan="5">After talking to other classmates about their results, you feel embarrassed because you did not get the “correct answer”. You decide to finish the report on your own and fabricate the last replicate.

The instructor discerns that you falsified some of your results and you receive no credit for the final lab report.

- negative</td><td rowspan="3">Your group talks to the TA about your conflicting results. The TA reiterates that negative results are still results and suggests that you include all of the results in your final lab report. The TA also discusses the results with the group and they include an explanation of why the results conflict. The instructor is impressed with the thoroughness of the lab report and you receive an A+.+ positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">Your group attends a Supplemental Instruction session to talk about your conflicting results. The SI reiterates that negative results are still results and suggests that you include all of the results in your final lab report. You receive an A- on the lab report.+ positive</td><td rowspan="3">After talking to other classmates about their results, you feel embarrassed because you did not get the “correct answer”. You decide to finish the report on your own and fabricate the last replicate. The instructor discerns that you falsified some of your results and you receive no credit for the final lab report.

- negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>Your group submits the report without addressing the differences in results and receives a B-.

- negative</td><td>Your group submits the report without addressing the differences in results and receives a B-.

- negative</td><td>You talk to a friend in your major about your conflicting results. They say that negative results are still results and suggests that you include all of the results in your final lab report. The instructor is impressed with the way you addressed the discrepancies in the lab report and you receive an B+.+ positive</td></tr>
</table>

Challenge 4: Continuing Research after the Class

It is the middle of the semester, and you are performing extremely well on all of your coursework in your CURE class. One day, your instructor announces that he is continuing this research over the summer and looking for undergraduate researchers to continue the project. He stated that he is looking for the *"best"* students to join his research team. This is of extreme interest to you.

What happens to your character? Roll the dice to find out.

Challenge 4: Continuing Research after the Class

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">The professor personally comes to you and says that he has noticed how engaged you are in class and that you would be a great fit for his research team. This boosts your confidence and you apply.

+ positive</td><td rowspan="3">You are very interested in the opportunity, but you meet some of the other students in the lab. You do not connect with them, and you do not want to be the only student of color in the lab, so you do not sign up.

- negative</td><td rowspan="5">You are interested in participating, but do not think the professor would want to work with you because of your lower GPA. You are nervous about talking about your lower grades in other classes, so you do not sign up for the research opportunity.

- negative</td><td rowspan="3">Research sounds like an exciting way to engage in your studies, but you worry that you are not one of the “best” in the class. You go to office hours and ask the professor what he is looking for. He describes the qualities he looks for and tells you that you would be a great fit! You apply. + positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">The professor personally comes to you and says that he has noticed how engaged you are in class and that you would be a great fit for his research team. This boosts your confidence and you apply. + positive</td><td rowspan="3">Summer research sounds like an exciting way to engage in your studies, but you worry that you are not one of the “best” in the class, so you do not apply.

- negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>Despite your professor suggesting you apply, you don’t have the time to balance school and sports with an outside lab opportunity, so you do not sign up.

- negative</td><td>You are very interested in the opportunity, but you meet some of the other students in the lab. You do not connect with them, and you do not want to be the only student of color in the lab, so you do not sign up.

- negative</td><td>You talk to the professor about your interest in research and they tell you that you have shown great aptitude for research, so you apply to be on his research team.

+ positive</td></tr>
</table>

Challenge 5: Presenting your Research

You are in a capstone/ senior level course-based research experience. Your instructor announces that the final will be a presentation at a conference in your field which is being hosted on your campus this year. Your group has the opportunity to present a poster at the conference. The symposium organizers are giving out awards for the best presentations and the instructor has agreed to award 5% points on top of the final grade of award winners. You are right on the edge between letter grades are excited to showcase what you and your group have accomplished. You are excited about this professional opportunity but also nervous because you have never been to a professional conference or given a research poster presentation before.

What happens to your character? Roll the dice to find out.

Challenge 5: Presenting your Research

<table>
<tr><th>Dice Roll</th><th>Lucas (must avoid a 6)</th><th>Christopher (must roll a 4 or 5)</th><th>Deborah (must roll a 6)</th><th>Lissette (must roll a 1, 2, or 3)</th></tr>
<tr><td>1</td><td rowspan="5">This is your first research presentation; but members of your family have done research presentations before, so you know what to expect. You and your group work really hard and receive 2nd place.

+ positive</td><td rowspan="3">When you go to register for the conference, you realize you cannot afford the $150 conference registration fee. You do not register and do not present your research. - negative</td><td rowspan="5">The schedule from your two jobs makes meeting with your group difficult. You all work independently and meet together once. The day of the presentation no one is prepared but you. You and your group do not receive an award. - negative</td><td rowspan="3">You practice frequently with one another and feel confident in your ability to deliver. You print your poster through UROC. You and your group receive 1st place.

+ positive</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td><td rowspan="2">When you go to register for the conference, you realize you cannot afford the $150 conference registration fee. A travel scholarship your instructor told you about helps you pay for the conference registration. You receive first place. + positive</td><td rowspan="3">You practice frequently with one another and feel confident in your ability to deliver. You volunteered to print your poster, but did not understand what that meant. You cannot afford to print it at the campus copy shop and do not know where else to go. Instead, you print out parts of your poster on regular pieces of paper and tack them up together. You and your group do not receive an award.

- negative</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>This is your first research presentation but members of your family have done research presentations before so you know what to expect. Therefore, you do not work as hard with your group and do not meet as often as you should. You do not place. - negative</td><td>When you go to register for the conference, you realize you cannot afford the $150 conference registration fee. You do not register and do not present your research. - negative</td><td>The schedule from your two jobs makes meeting with your group difficult, but your group meets on Saturday mornings on Skype to plan and practice the presentation. Presentation day you deliver and receive 3rd place.

+ positive</td></tr>
</table>

Summary of Outcomes

Characters with 2 positive outcomes or less: You receive a C- or lower in the class, and have no interest in pursuing undergraduate research after this course. In fact, you are not sure what research looks like and why people do research. Furthermore, you feel that research is not for people like you.

Characters with at least 3 positive outcomes: You receive a B in the CURE but have no interest in continuing to pursue research. You feel that only extremely intelligent people are able to do research, and doubt that you are one of those people.

Characters with at least 4 positive outcomes: You receive an A- or higher in the CURE and plan to pursue other research opportunities on campus. You are also exploring careers related to your research interests. There are so many opportunities in your field and you cannot wait to contribute.

References

Ahmed, S. (2012). *On being included: Racism and diversity in institutional life*. Durham: Duke University Press.

Aikens, M. L., Sadselia, S., Watkins, K., Evans, M., Eby, L. T., & Dolan, E. L. (2016). A social capital perspective on the mentoring of undergraduate life science researchers: An empirical study of undergraduate-postgraduate-faculty triads. *CBE Life Sciences Education*, *15*(2). doi.org/10.1187/cbe.15-10-0208

Alexander, J. M. (2005). *Pedagogies of crossing, meditations on feminism, sexual politics, memory, and the sacred*. Durham: Duke University Press.

Ali, S. (2009). Black feminist praxis: Some reflections no pedagogies and politics in higher education. *Race, Ethnicity, and Education*, *12*(1), 79-66. doi.org/10.1080/13613320802650998

Bachen, C., Hernández-Ramos, P., & Raphael, C. (2012). Simulating REAL LIVES. *Simulation & Gaming, 43*(4) 437–60. https://doi.org/10.1177/1046878111432108.

BrckaLorenz, A., Duran, A., & Haeger, H. (2020). Culturally engages courses and campuses for LGBQ+ issues. *Journal of Diversity in Higher Education* doi.org/10.1037/dhe0000177.

CSUMB, Institutional Assessment and Research. (2020) Enrollment fast facts (most recent term). Retrieved from https://csumb.edu/iar/enrollment-fast-facts-most-recent-term CSUMB.

Chang, M. J., Sharkness, J., Hurtado, S., & Newman, C. B. (2014). What matters in college for retaining aspiring scientists and engineers from underrepresented racial groups: Retaining aspiring scientists. *Journal of Research in Science Teaching*, *51*(5), 555–580. https://doi.org/10.1002/tea.21146

Clancy, K. B. H., Nelson, R. G., Rutherford, J. N., & Hinde, K. (2014). Survey of Academic Field Experiences (SAFE): Trainees Report Harassment and Assault. *PLOS ONE*, *9*(7), e102172. doi.org/10.1371/journal.pone.0102172

Collins, P.H. & Bilge, S. (2016). *Intersectionality (key concepts)*. Cambridge: Polity Press.

Deem, R. & Ozga, J. (1997). Women managing for diversity in a postmodern world. In C. Marshall (ed.), *Feminist critical policy analysis: A perspective from postmodern secondary education*. London: Falmer Press, 25-40.

Crenshaw, K. (1991). Mapping the margins: Intersectionality, identity politics, and violence against women of color. *Stanford Law Review, 43*(6), 1241-1299. doi.org/10.2307/1229039

Estrada, M., Hernandez, P. R., & Schultz P. W. (2018). A longitudinal study of how quality mentorship and research experience integrate underrepresented minorities into STEM careers. *CBE—Life Sciences Education 17*(1). doi.org/10.1187/cbe.17-04-0066.

Gutierrez, B., Kaatz, A., Chu, S., Ramirez, D., Samson-Samuel, C., & Carnes, M. (2014). "Fair play": A videogame designed to address implicit race bias through active perspective taking. *Games for Health Journal 3*(6), 371–78. https://doi.org/10.1089/g4h.2013.0071.

Haeger, H., BrckaLorenz, A., & Webber, K. (2015). Participation in undergraduate research at minority serving institutions. *Perspectives on Undergraduate Research and Mentoring*, *4*(1). Retrieved from http://blogs.elon.edu/purm/files/2015/11/Haeger-et-al-PURM-4.1-1.pdf

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.16-01-0016Hensel, N. H. (2018). *Course-based undergraduate research: Educational equity and high-impact practice*. Sterling, Virginia. Stylus Publishing, LLC.

Hurtado, S., Eagan, M. K., Tran, M. C., Newman, C. B., Chang, M. J., & Velasco, P. (2011). "We do science here": Underrepresented student's interactions with faculty in different college contexts. *Journal of Social Issues*, *67*(3), 553–579. doi.org/10.1111/j.1540-4560.2011.01714.x

Jones, M. T., Barlow, A. E. L., & Villarejo, M. (2010). Importance of undergraduate research for minority persistence and achievement in biology. *Journal of Higher Education*, *81*(1), 82–115. doi.org/10.1353/jhe.0.0082

Kilanowski, J. (2017). Breadth of the socio-ecological model. *Journal of Agromedicine, 22*(4), 295-297. doi.org/10.1080/1059924X.2017.1358971

Kinzie, J., Gonyea, R., Shoup, R., & Kuh, G. D. (2008). Promoting persistence and success of underrepresented students: Lessons for teaching and learning. *New Directions for Teaching and Learning*, *2008*(115), 21–38. doi.org/10.1002/tl.323

Kuh, G. D. (2008). *High - impact educational practices: What they are, who has access to them, and why they matter.* Washington, D.C.: AAC&U.

Mohanty, C.T. (2003). *Feminism without borders: Decolonizing theory, practicing solidarity.* Durham: Duke University Press.

Milem, J. F., Chang, M. J., & Lising Antonio, A. (2005). *Making diversity work on campus: A research-based perspective.* . Washington, DC: Association of American Colleges and Universities.

National Academies of Sciences, Engineering and Medicine. (2017). Undergraduate research experiences for STEM students: Successes, challenges, and opportunities. Washington, DC: The National Academies Press. doi.org/10.17226/24622

National Academy of Sciences, National Academy of Engineering, & Institute of Medicine. (2011). Expanding underrepresented minority participation: America's science and technology talent at the crossroads. Washington, DC: The National Academies Press. doi.org/10.17226/12984

National Math + Science. (2010). Increasing the achievement and presence of under-represented minorities in STEM fields [White Paper]. Retrieved from http://nms.org/Education/TheSTEMCrisis.aspx

Nikolova Eddins, S. G., & Williams, D. F. (1997). Research-based learning for undergraduates: a model for merger of research and undergraduate education. *Journal on Excellence in College Teaching*, *8*(3), 77–94. ISSN: ISSN-1052-4800

Puwar, N. (2004). *Space invaders: Race, gender, and bodies out of place.* Oxford: Berg Press.

Robnett, R. D., Chemers, M. M., & Zurbriggen, E. L. (2015). Longitudinal associations among undergraduates' research experience, self-efficacy, and identity. *Journal of Research in Science Teaching*, *52*(6), 847–867. https://doi.org/10.1002/tea.21221

Schinske, J. N., Perkins, H., Snyder, A., & Wyer, M. (2016). Scientist spotlight homework assignments shift students' stereotypes of scientists and enhance science identity in a diverse introductory science class. *CBE—Life Sciences Education 15*(3), 1-18. doi.org/10.1187/cbe.16-01-0002

Sweeney, J. K., & Villarejo, M. (2013). Influence of an academic intervention program on minority student career choice. *Journal of College Student Development*, *54*(5), 534–540. https://doi.org/10.1353/csd.2013.0070

Villarejo, M., Barlow, A. E. L., Kogan, D., Veazey, B. D., & Sweeney, J. K. (2008). Encouraging minority undergraduates to choose science careers: Career paths survey results. *CBE Life Sciences Education*, *7*(4), 394–409. doi.org/10.1187/cbe.08-04-0018

Wilson, A., Howitt, S., & Higgins, D. (2015). A fundamental misalignment: Intended learning and assessment practices in undergraduate science research projects. *Assessment and evaluation in Higher Education, 41*(6), 869-884. *(*doi.org/10.1080/02602938.2015.1048505

JoSoTL is a FACET publication.
facet.iu.edu

Contact Information for the Journal

Email: josotl@iu.edu

Website: josotl.iu.edu

ISSN: 1527-9316

JoSoTL Editorial Office

Indiana University
107 S. Indiana Avenue
Bryan Hall 203B
Bloomington, IN 47405