# COEUR 2.0

## Characteristics of Excellence in Undergraduate Research

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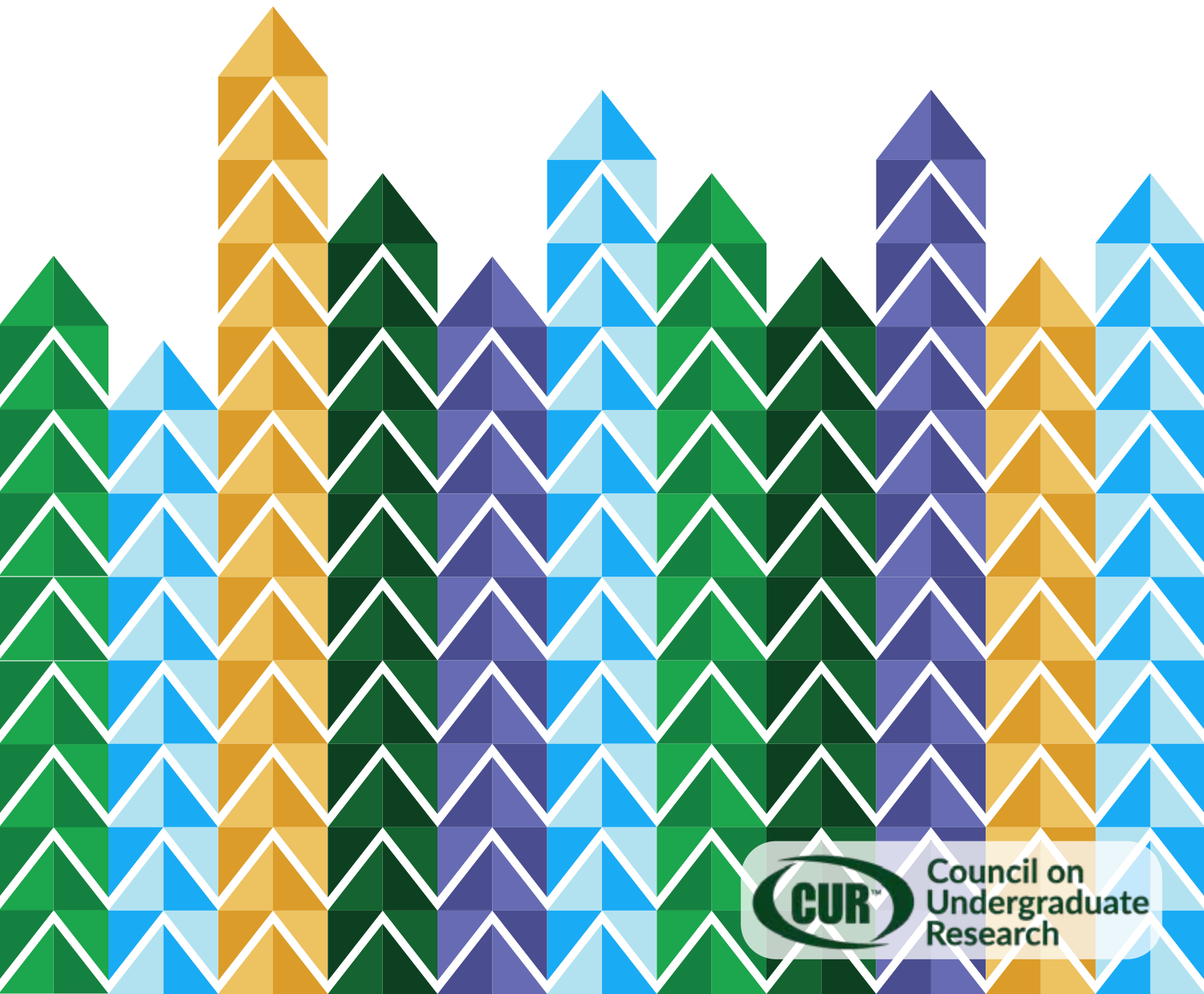
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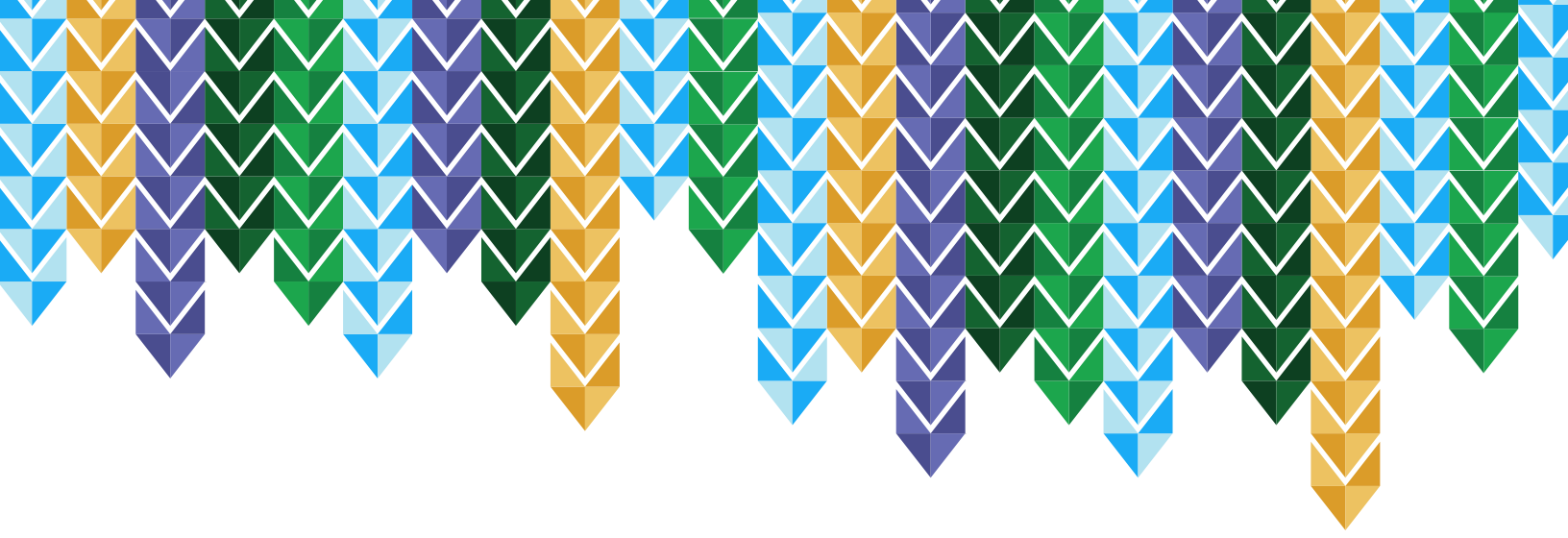
The views expressed by contributors in this publication reflect their own experiences and insights.
The Council on Undergraduate Research recognizes that these approaches may not work equally well
on all campuses and should be seen as prompts for consideration rather than definitive solutions.
We encourage readers to adapt these ideas to fit their unique contexts and needs.

Characteristics of Excellence in Undergraduate Research 2.0

CHARACTERISTICS OF EXCELLENCE IN UNDERGRADUATE RESEARCH 2.0

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Introduction

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In the twelve years since the original *Characteristics of Excellence in Undergraduate Research* (*COEUR*) was published, *COEUR* has been an extraordinary road map that has helped many establish undergraduate research offices, design new programs, communicate aspirations to and request commitment from leadership, and recognize the support needed to ensure that undergraduate students engage in one of the most impactful educational practices at their colleges and universities.

How has the higher education landscape changed in twelve years to warrant a version 2.0? For one, the demographics of the student population are changing at the national level. The number of students who come from minoritized populations, are first-generation college attendees, are financially disadvantaged, or are of non-traditional age attending college, is at record numbers. These students bring assets and requirements to the undergraduate research enterprise that may differ from the "classical" students of the 80s, 90s, and turn-of-the-century. Another significant change is the number of students attending community college before transferring to 4-year universities. This decision has multiple reasons, including the cost, the need to explore different fields before deciding on a major, and the interest in short-term training to join the workforce. This fact points to the need for more community colleges to play a role in preparing students to participate in undergraduate research programs at other institutions or provide those experiences on their campuses. There has also been tremendous momentum in course-based undergraduate research experiences (CUREs), which can broaden the number of students receiving research training at any level within their college/university trajectory and include students who otherwise lack the time for a more intensive and traditional research experience.

Over the past twelve years, numerous published studies have constantly shown that engaging students in undergraduate research, scholarship, and creative inquiry results in higher retention, improved graduation rates, increased entry into advanced degrees, and better career preparation and opportunities. Also of note are the publications providing evidence of the importance of faculty and post-graduate students receiving mentor training.

We would be remiss not to include the relevance of assessment and evaluation to ensure students are intentionally receiving the best services and experiences from undergraduate research offices, programs, and mentors, as well as to confirm research mentors are receiving the training and support needed for them to provide the best training possible for their students. In addition, research self-efficacy, science identity, and sense of belonging have been established as hallmarks of success in science, technology, engineering, mathematics, and medicine (STEMM) disciplines, thus necessitating the involvement of evaluators to collect that information at programmatic and institutional levels. A positive consequence of all the evidence collected by research and evaluation efforts is that federal agencies are funding research programs at record numbers.

In *COEUR 2.0*, we have made several updates. The number of characteristics has been streamlined from 12 to 11, with the Strategic Planning characteristic now incorporated into the Campus Mission and Culture. We have also strongly emphasized diversity, equity, inclusion, and access in all the characteristics. Additionally, we have included a discussion on integrating research, scholarly work, and creative inquiry with other high-impact practices, such as community engagement, study abroad, internship, and work-based learning. Separate chapters on these topics have been added to provide the best approaches for research ethics training.

Additional chapters featuring how institutions have incorporated the Characteristics of Excellence follow the eleven characteristics. There is also a chapter on Student Voices, which demonstrates the impact that participation in undergraduate research, scholarship, and creative inquiry has had on students from all walks of life. The inclusion of this chapter also supports students as collaborators throughout the research process.

Higher education continues to be shaped by a rapidly changing world. We hope that this updated version of *The Characteristics of Excellence in Undergraduate Research* not only captures the current framework for building successful and accessible undergraduate research programs, but also provides a sustainable foundation that will yield increasing engagement from diverse students, faculty, staff, and administrators that extends beyond this critical high impact practice. While not all institutions and programs can aspire to fulfill all the characteristics, we invite you to examine them and read the personal stories of individuals, institutions, and students as a testament to what is possible when we aim for excellence.

Characteristics of Excellence in Undergraduate Research

The mission of the Council on Undergraduate Research (CUR) is to support and promote high-quality mentored undergraduate student-faculty collaborative research and scholarship. CUR defines undergraduate research as a mentored investigation or creative inquiry conducted by undergraduates that seeks to make a scholarly or artistic contribution to knowledge. Undergraduate research, a term that encompasses scholarship and creative activity, is recognized as a high-impact educational practice that has the ability to capture student interest, create enthusiasm for and engagement in an area of study, and prepare students for the work world.

CUR, as the leading voice in undergraduate research, has more than 45 years of experience working with faculty and institutions to build and sustain undergraduate research and with evaluating undergraduate research programs. This document represents a compilation of the experience of CUR in building and evaluating undergraduate research programs at all types of institutions, including public and private, primarily undergraduate through research-intensive. This document is intended as a guide for those who oversee undergraduate research and those who wish to build, evaluate, and maintain robust, productive, meaningful, and sustainable undergraduate research programs. Institutions, programs, academic departments, faculty, and administrators should find this document valuable as they work to develop and enhance their undergraduate research enterprise.

The *Characteristics of Excellence in Undergraduate Research (COEUR)* is a summary of best practices that support and sustain highly effective undergraduate research environments. This document is organized into sections that correspond to various functions or units of a typical college or university campus. Whenever the term undergraduate research, scholarship or creative inquiry is used throughout this document, we are being inclusive of all disciplines. In CUR's experience, successful programs exhibit many of the characteristics enumerated in this document. Further, many of the characteristics described in this document overlap and are important elements in an integrated, synergistic approach to enhancing undergraduate research.

1. Campus mission and culture

Creating a campus culture that values and rewards undergraduate research is essential for sustaining a robust undergraduate research program. CUR believes that such a culture emerges when institutions have a scholarly faculty and leaders committed to providing high-quality undergraduate research experiences for students; broad disciplinary participation in undergraduate research; opportunities that are equitable, accessible to a wide cross-section of students; a strong emphasis on ethical conduct in research; and connected to career readiness competencies.

1.1   Institutional commitment

Institutional commitment to undergraduate research as a high-priority activity for its faculty and students is essential for creating a successful undergraduate research ecosystem. College administrators must clearly articulate how undergraduate research aligns with the mission and/or strategic plan of the institution. Providing appropriate resources and recognition to faculty and students engaged in research will increase the success and sustainability of undergraduate research initiatives. Involvement of other campus constituents, such as

- student-affairs personnel (e.g., in providing on-campus housing for summer undergraduate researchers),
- facilities/physical plant staff (e.g., in creating appropriate spaces for research),
- the office of human resources (e.g., in working with student payroll),
- the office of advancement/development (e.g., in fundraising for undergraduate research),
- the office of scholarships and fellowships (e.g., in promoting opportunities that involve undergraduate research),
- career services (e.g., supporting faculty and students in telling the undergraduate research story),
- the office of research and sponsored projects (e.g., in ensuring faculty are aware of and apply for grants that support undergraduate researchers),
- diversity, equity, and inclusive excellence office, when allowed by state law (e.g., in ensuring first-generation students and/or students from historically underrepresented and excluded minority groups are aware of opportunities and that faculty constructing undergraduate research experiences have training regarding the establishment of inclusive and equitable mentoring practices),
- Institutional Review Boards that engage with students (e.g., in training and supporting them with the process of designing ethical research methodologies),

are also necessary in creating a campus climate that effectively promotes undergraduate research. Specific ways in which institutions can demonstrate their commitment to creating a culture that values and encourages undergraduate research are described in subsequent sections of this document.

1.2   Scholarly faculty

A key component to a successful undergraduate research environment is an institutional commitment to a scholarly faculty. For students to derive the most out of an undergraduate research experience, it is important for faculty to be current and active scholars in their fields. Institutions that adopt a teacher-scholar model, in which faculty are expected to regularly produce scholarship that is recognized by their peers and in which a premium is placed on teaching, have in place one critical element of effective undergraduate research mentorship and productivity.

1.3   Faculty commitment

A scholarly faculty is necessary but not sufficient to establish and sustain an outstanding undergraduate research environment. Faculty members also must be committed to undergraduate research as an important part of their roles and responsibilities. Not all faculty scholarship will involve undergraduates, but it is essential that faculty members value both the contribution of undergraduates to scholarship and the participation of undergraduates in scholarly activities as an important part of their education. Further, faculty should be encouraged and supported to develop skills that reduce implicit bias and/or assumptions around students as partners in the research process and the interpretation of research readiness or predicted proficiency. Such faculty should seek to create opportunities for undergraduates to be involved in research, both outside and, when appropriate and relevant to the institution, inside the classroom through course-based undergraduate research experiences (CUREs).

1.4 Broad disciplinary participation

Institutions with highly successful undergraduate research environments have faculty and student involvement across diverse disciplines so that students have research options in as broad a range of inquiry as possible. Students majoring in all academic areas, including professional disciplines, should have opportunities to participate in faculty-mentored research, scholarship, and creative activities. Institutions that support and encourage interdisciplinary teams are engaging in a best-practice approach to recruit and sustain the involvement of first-generation, historically underrepresented and excluded students from minority communities.

1.5 Accessible opportunities for undergraduates

The intellectual experience of pursuing research is beneficial to all students. As such, engagement in undergraduate research should not be limited solely to seniors or to honors-level students. Research suggests that students who engage in undergraduate research in their sophomore year or at least by their junior year are more likely to connect and pursue further education or opportunities within their major area of study. Therefore, undergraduate research opportunities should be accessible to as broad a range of students as is practical, including first-year, transfer, online learners, embedded in the curriculum, as an option for work study for high financial need students, and via community-based participatory research. Undergraduate research participation has been linked with greater retention and graduate school enrollment for first-generation and minority students, particularly in STEMM (science, technology, engineering, mathematics, and medicine) fields. However, pathways to undergraduate research engagement that are not intentionally created with inclusive and equitable frameworks may reinforce barriers for some students who may benefit the most from this high-impact practice.

Specific barriers may include assumptions around the level of awareness of research opportunities and pathways to engage; whether the benefits of participating in research are adequately shared broadly with students; and perceptions of faculty mentor accessibility; financial and personal needs; and biases regarding the assessment of research readiness that aligns with majority cultural norms (Bangera and Brownell, 2014; Longmire-Avital, 2018). A robust undergraduate program actively engages undergraduate students from diverse backgrounds and majors. Undergraduate research is a vehicle for developing disciplinary identity and belonging, a critical aspect of prolonged engagement in academic and applied fields.

1.6 Integration with other engaging and high-impact opportunities

The undergraduate research enterprise on a campus should be integrated and coordinated, where possible, with other high-impact practices to maximize student development, leverage resources, and incorporate undergraduate research across the institution. While some collaborations will be more obvious (e.g., honors programs; building research awareness in a first-year orientation class; working with service or community-based learning initiatives to develop community-based research projects; helping student researchers apply for national fellowships), other less obvious partnerships can provide another layer of excellence for students. These include study abroad (international research experiences); leadership programs (enhancing leadership and peer-mentoring skills); career centers (leveraging research experiences into employment and new career directions); residential life (residence halls with research-themed learning communities); centers for entering student experiences, and centers for community engagement (community-based participatory research), as well as opportunities to use research as a tool for social action and change. Additionally, leaders of broad learning and education initiatives (e.g., general education, global citizenship, communication proficiency, diversity, equity, and inclusive excellence divisions) should look to undergraduate research programs to further their goals, and leaders of undergraduate research should look to such initiatives for approaches to maximize student learning, such as first-year research methods courses and CUREs, and including undergraduate research into capstone courses.

1.7 Strategic planning

Institutions that aspire in creating and sustaining an excellent undergraduate research environment will have thoughtful and clearly articulated benchmarks and strategic plans. Strategic plans should address inclusive and equitable recruitment efforts, goals for student and faculty participation in research (relating to quality, quantity, breadth of disciplines, and inclusion of a diversity of participants), mechanisms for identifying and scaling up effective programs, an audit of current or potential barriers preventing equitable access, and resources to test and implement new programs to provide appropriate opportunities for different levels of students, in or outside of the curriculum. Strategic plans should also recognize the resources needed for diversifying, expanding, and enhancing programs, including faculty contributions, staffing needs, space, and fiscal resources.

1.7.1 Recruitment

A marker of a robust undergraduate research program is the sustained, if not growing, number of engaged students and faculty. Aspirational undergraduate research programs prioritize recruitment and retention of their students and faculty. Recruitment plans are a critical opportunity to build and strengthen diversity, inclusion, and equity efforts by intentionally accessible designs. Undergraduate research programs should not rely on faculty to invite interested students. This often-used recruitment strategy cannot be disentangled from possible implicit bias, potentially inaccurate assumptions of student readiness or fit with ongoing research projects, and interest. It links student participation to certain classes, which may overlook or uphold underrepresentation from the participation of students and faculty in a variety of disciplines across the institution as well as sociodemographic groups. Instead, consider undergraduate research fairs or open houses to inclusively introduce students to research at the institution and opportunities to engage. Develop and use partnerships across the institution to create pathways for engaging in undergraduate research. Excellent undergraduate research programs invest in a web presence that clearly outlines the steps for getting involved in undergraduate research. Programs should consider how their websites can be linked with other highly trafficked websites used by the students at the institution. For example, websites listing activities and opportunities through student affairs, first-generation centers (Manak and Shanahan, 2015), or other various diversity, inclusion, and equity offices might be ideal spaces to hyperlink to the undergraduate research program. Developing short presentations for in-person delivery or video access could be shared with multiple areas across the institutions. This content should be developed for both student and staff audiences. Departments can also use their own websites and communication materials to showcase student engagement as well as steps to engage in undergraduate research. Additional suggestions can be found in Pierszalowski and Buser's (2021), Mentoring Guidebook. An equitable and feasible recruitment plan is one of the essential first steps in building a dynamic undergraduate research program of exceptional quality and impact.

2. Administrative support

While faculty members are critical in the implementation of undergraduate research, administrative support, and commitment are essential to sustain the undergraduate research enterprise. Support can be construed in terms of funding, supplies, and equipment, but also in time, personnel, recognition and reward models, and administrative flexibility and creativity.

2.1 Internal budgetary support

To build and sustain successful undergraduate research ecosystems, expectations for faculty-student scholarship must be accompanied by appropriate resources. Successful institutions recognize that undergraduate research is associated with real costs for materials, infrastructure and personnel, and they use that understanding in allocating funds and other necessary resources to academic departments, programs, and perhaps individuals. Different disciplines will have varying needs for internal budgetary support for undergraduate research; however, administrators should recognize that undergraduate research requires financial, facilities, and human resources for all disciplines. In addition, institutions should recognize the need to provide matching funding for research grants from external sources, when appropriate, and to provide for long-term operational and maintenance costs for acquired research equipment and/or infrastructure.

2.2 Startup funding

Faculty startup funding to support scholarship should be commensurate with institutional expectations for scholarship and undergraduate student participation in faculty research. New faculty should be awarded startup research funding to establish the necessary infrastructure and purchase research materials to enable them to begin effective and productive research. Startup funding packages might provide items such as specialized research equipment or research materials (e.g., journals, books, databases, software), funds to travel to research sites or archives, and faculty and/or student research stipends. Appropriate time for faculty to develop their research space should also be provided. In disciplines in which external funding is available, startup funding should be sufficient to help faculty develop a scholarly track record that will allow them to be competitive for external research funding.

2.3   Faculty load credit for supervising undergraduate research

If undergraduate research is an institutional priority that fulfills a critical role in student education and scholarship, then the time for faculty to engage in research and mentor undergraduate students must be protected and rewarded. At institutions where most faculty members have heavy teaching loads, faculty should be appropriately compensated, through teaching load credit or reassigned time, for supervising undergraduate research. More research-intensive, doctoral-granting institutions also should recognize the importance and time-consuming nature of faculty work with undergraduates. There are various models of how to compensate faculty with course-load credit, including having undergraduate research count as part of the faculty member's credit-hour load (as much or more than 10 percent of one's teaching load credit at predominantly undergraduate institutions); rotating load credit among faculty within departments; offering additional support (in the form of teaching assistants, higher load credit, extra funds for materials and supplies, or smaller class sizes) for courses that contain a course-based undergraduate research experience (CURE), or offering small-enrollment courses in which faculty receive credit for teaching their research team.

Models should also consider compensation structures for research teams. Multiple undergraduate mentors working with a group of students is a successful model for engaging first-generation, historically underrepresented/ excluded students. However, it moves away from the traditional model of having a one-to-many faculty-student ratio. This type of research team or lab is effective, but models for compensation must be able to equitably accommodate this structure for compensation.

High-quality undergraduate research experiences involve impactful and custom-fitted meaningful mentoring relationships (Longmire-Avital, 2020a). These relationships have the potential to be long-lasting and require ongoing personal investment that may not be easily documented. Efforts are necessary to provide professional development for all while concurrently acknowledging that undergraduate research mentoring may result in invisible work, particularly for faculty that belong to a historically underrepresented and excluded minority identity group, is critical.

2.4   Reassigned time for research-related tasks

In addition to receiving workload compensation for supervising undergraduate research, providing appropriate reassigned time for faculty to engage in research-related tasks is likewise important. Faculty, especially those with relatively heavy teaching loads at primarily undergraduate institutions, may face difficulty in finding sufficient time to write research grant proposals, complete scholarly articles or books, or coordinate and administer such research activities as serving on research-related committees (Institutional Review Board, facilities, library acquisitions, etc.), supervising personnel, or administering multi-faculty research projects. These are essential activities for maintaining active and robust research programs, however, and many institutions support these activities through reassigned time for faculty.

2.5   Undergraduate research administrative support
2.5.1   Undergraduate research program office

Most highly successful undergraduate programs are associated with a central office of undergraduate research, which oversees campus-wide undergraduate research activities that include but are not limited to on-campus research symposia, summer research, student workshops, mentorship training, and disbursement of funds for student travel. A centralized office of undergraduate research is well positioned to promote equitable access to opportunities (Pierszalowski 2021). Some undergraduate research offices may award internally or externally funded research assistantships to students and/ or faculty. The establishment of a designated position for an undergraduate research program director provides a clear statement of the importance and expected potential of the undergraduate research enterprise on a campus. The program director's position (and associated costs) should be funded through the institutional budget, rather than depending on soft money, even though new initiatives funded through external grant dollars are often the catalyst for creating a position that evolves into a permanent post on campus. Where the program director is placed in an institution's organizational structure is critical, but this will likely vary by institutional type and idiosyncrasies of each campus environment. The director of undergraduate research should have appropriate professional credentials, such as a faculty member with experience in mentoring undergraduate research or a staff member with a master's degree in an academic discipline or in student affairs and prior entry-level experience. Additionally, support for continued professional development for the director is critical to establishing and sustaining a level of excellence for the undergraduate research environment.

Some institutions do not have the demand or resources for full-time professional staffing for an office of undergraduate research or for a director of undergraduate research; some may instead have an appointed coordinator of undergraduate research (often a faculty member committed to and knowledgeable about undergraduate research issues with reassigned time devoted to this role). Having a central advocate for undergraduate research on campus is important for publicity, coordinating campus undergraduate research events, maintaining awareness of internal and external opportunities for enhancing undergraduate research, building institutional collaborations and relationships (e.g., career services, access and diversity, equity, and inclusion (DEI) centers) and conducting assessments. Awareness of external opportunities should consider cross-institutional partnerships with minority serving institutions and community colleges. These partnerships should be mutually beneficial.

Some offices/coordinators of undergraduate research work with a campus advisory board, which often includes student members. These boards are an important element for building advocacy and for providing direction and guidance. Given, the key role these advisory boards play in the sustainment of high-quality undergraduate research experiences and infrastructure, boards should not only be representative of various academic areas but also reflective of diverse perspectives and student/faculty experiences.

2.5.2   Space

Adequate administrative space should be provided in a location on campus with high student and faculty visibility, possibly near other similar administrative or student services offices, and with easy access to meeting rooms. Affordable, highly visible space also should be easily available for campus-wide symposia/celebration days. When a faculty member assumes the role of campus undergraduate research coordinator on a rotating basis, it can be disruptive to the establishment and long-term growth of the program to rotate the office to the coordinator's departmental office.

2.5.3   Infrastructure support

Funding should be provided for routine office expenses (including computer and software upgrades), the costs of workshops and events, publicity, professional development for the coordinator, and membership dues for the coordinator's CUR membership. The publicity budget should include funds for outreach internally to students and faculty, as well as resources to promote the program's success stories to a broader audience. External publicity may be best done in partnership with other offices on campus.

2.6   Travel and other student funding

Both faculty and student scholars greatly benefit from presenting research results at professional meetings and conferences. This activity provides faculty and students the opportunities to build professional networks and generate and discuss research ideas. Institutions with exemplary undergraduate research programs provide sufficient funds for faculty and students to present research results at a minimum of one professional meeting or conference each year. Institutions should have clearly articulated processes for funding and reimbursing travel and providing staff support so the burden of navigating the university funding process does not fall on the faculty mentors or students. In addition, exemplary institutions provide funding for faculty to travel with undergraduates to conferences the individual faculty might not otherwise attend, such as student-centered conferences. Having faculty at these meetings helps students gain the most from their conference experience. In addition to providing funding for student travel to present their completed research, offices of undergraduate research often support an internal program of small equipment, supplies, and travel grants to help students initiate their research. The financial aid department should also be engaged in the support of funded undergraduate research experiences. Their involvement is critical in avoiding unintended impacts of such funding on the student's financial aid package.

2.7   Research grants office

Institutions should have a research grants office to keep track of and alert faculty to funding opportunities. An office of sponsored research will also manage the grant application process, including electronic submissions with the appropriate institutional certifications, and will assist faculty with post-award administration. In cases where the establishment of an independent grants office is not possible, institutions must designate a knowledgeable person to be responsible for acting as the institutional representative for grant submissions; this person must be given sufficient reassigned time to perform this job well. Institutions with established units for administering grants should work to ensure that faculty members submitting proposals are

aware of funding opportunities to involve undergraduates in their work and that they know about internal resources and programs that could bolster their proposals and help them achieve maximum impact and efficiency. Grants staff should also be available to assist with student-initiated proposals for external grants or awards that require institutional consent and support.

3. Research infrastructure

An essential feature of a supportive undergraduate research environment is infrastructure. Without appropriate space, equipment, and other research resources, even the most talented and creative faculty members cannot sustain productive research and scholarship that involves undergraduates.

3.1 Physical and virtual research space

Institutions must provide adequate, dedicated physical and virtual space for the undergraduate research enterprise to flourish; this is especially critical in the sciences, engineering, and creative arts, but it is relevant to all fields of study because secure but accessible space is necessary for faculty and students to gather for research conversations and activities. Classrooms or teaching laboratories/studios are not typically properly configured to accommodate research activities, and they may not be available at the right times or for sufficient blocks of time for productive faculty-student collaborative research to be performed. In the experimental sciences, a typical faculty-student research laboratory is 500 to 600 square feet in size, and depending on the field, due to OSHA regulations, it may or may not include a dedicated desktop workspace for students. Laboratory and studio spaces should meet modern lighting, safety, and ventilation requirements and be properly climate-controlled for use year-round. Private space may be needed for confidential research interviews, focus groups, or observational studies. For all fields of study, a comfortable conference and meeting space is critical; ideally this space would be in locations near faculty offices, studios, or laboratories. Research data and supplies should be kept in a secure location for reasons of confidentiality and safety. Appropriate virtual labs and conferencing software are critical infrastructure elements for online undergraduate research experiences.

Research practices continue to evolve. Some areas of research have moved from primarily lab-based or tied to academic locations to community-based and virtual. Virtual research experiences should align with in-person undergraduate research mentorship experiences. Using virtual meeting software, faculty should be in regular contact with their students. The pivot to a virtual research experience allows for faculty and students to minimize disruption to research projects that typically result from either faculty or student leaves. It may also facilitate research over the summer, increase opportunities for research abroad, and the use of international or cross-country collaborations. Faculty conducting virtual research and/or virtual undergraduate research mentorship will need access to software and programs that allow for sharing and simultaneous access. Security of software and data collection must also be considered.

3.2 Instrumentation and equipment

In the experimental sciences and creative arts, instrumentation and appropriate studio equipment are critical for effective research and education. Exemplary undergraduate research programs have on-campus and virtual access to the appropriate instrumentation and equipment required for faculty-student collaborative research, and the institutions have well-defined departmental and institutional plans for the acquisition, maintenance, and periodic replacement of this infrastructure. At institutions without appropriate on-campus instrumentation, campuses should make arrangements to use equipment housed at nearby facilities (e.g., a relatively small, primarily undergraduate institution might arrange to make use of the core facilities at a nearby research institution).

3.3 Library resources

To sustain a successful undergraduate research program, it is essential to have adequate and accessible library resources so that faculty and students can investigate new research ideas, search for information, prepare competitive research proposals, and write research manuscripts and student research theses and reports. Inadequate library resources can be a significant barrier to the productivity and long-term success of an undergraduate research program. Faculty and students should have access to primary literature, and institutions should have a strategy for acquiring appropriate journals, online subscriptions, databases, monographs, and books to support undergraduate research. In cases where appropriate collections are not available on-site, institutions should provide timely interlibrary loans or other means of acquiring needed documents and/or make funding available for faculty and

students to travel to necessary collections. Faculty and student researchers must have access to appropriate disciplinary tools for searching primary literature and obtaining up-to-date information (e.g., SciFinder Scholar, Web of Science, EBSCO). Support for information-literacy training and development of research skills should be built into the curriculum or be part of a workshop series for undergraduate researchers.

3.4 Computational resources

Faculty should be provided with computer hardware equipped with an operating system of their choice, suitable for using software and utilities appropriate to research in their discipline. Similarly, students should be able to access computing equipment appropriate for the research they are conducting. A high-speed computer network should be available in offices, research spaces, and virtually, and this network should support typical protocols required for research.

3.5 Other research resources

Faculty and students may also need access to museum collections; local, national or regional archives; geological samples; historical artifacts; or other specialized research materials germane to their research. If these are not available on-campus, institutional support to borrow or travel to these resources is critical.

3.6 Research oversight structures

Any institution conducting research with undergraduates needs to have certain research oversight structures in place, including an Institutional Review Board (IRB) for research projects involving human subjects; an Institutional Animal Care and Use Committee (IACUC) for research projects involving vertebrate animals; chemical, environmental, and biological hazard training, policies and oversight structures, and training and oversight structures to support responsible conduct of research. These and other mechanisms are required to comply with state and federal regulations for relevant research projects, and they are likely to be a condition for research funding. In the case of ethical review committees, they also provide oversight for the training of undergraduates in research ethics associated with human and animal subjects. The IRB and IACUC (if present) should be prepared and open to support student projects by creating oversight and approval processes that meet the unique timeline and needs of student projects and course-based undergraduate research experiences (CUREs).

3.7 Support, administrative, and technical staff

Many institutions have discovered that support and technical staff can enhance undergraduate research by allowing faculty and students to focus more effort on research, rather than spending valuable time tending to administration of research and teaching or maintenance and repair of equipment. For example, laboratory or studio support staff can stock supplies, configure computer equipment, and/or prepare materials for teaching laboratories; instrument technicians can install and provide preventive and unscheduled maintenance for equipment; technicians can order and maintain supplies, and/or prepare routine research materials; administrative assistants can oversee fiscal management of project expenses, arrange student funding and travel reimbursements, and coordinate review processes by working with the IRB and IACUC. Additional support with computer maintenance, curating artifacts and artwork, and library references can make for a more effective research environment.

4. Professional development opportunities

To remain effective scholars throughout their careers, faculty need the opportunity to learn new research methodologies, obtain recurrent research training, establish external research collaborations and scholarly networks, complete scholarly pursuits, freshen mentorship skills, and develop strategies to ensure inclusive research environments as well as practices to ensure the highest levels of accessibility for all students (e.g., restorative agreements, how to engage in and encourage asset- or cultural capital- mapping for students (Longmire-Avital, 2019; Mekolichick and Gibbs, 2012; Shanahan, Ackley-Holbrook, Hall, Stewart and Walkington, 2015; Yosso, 2005), developing and using positionality statements embedded within bios to foster relationship building, and facilitating dialogue in addition to developing inclusive group processes). Many of these activities are part of a robust faculty mentoring program. Such professional development opportunities are critical to undergraduate research because faculty members who are current scholars in their areas of expertise are able to engage students in research that is relevant and conforming to modern praxis. Other professionals involved in overseeing undergraduate research also benefit from professional development, and relevant opportunities should be made available to them too.

4.1   Research leaves

Professional leaves are essential for faculty to remain current, knowledgeable, productive scholars and, by extension, effective mentors of undergraduate research. Thus, institutions should promote regular opportunities for research leaves, and if possible, this should include both sabbaticals and leaves for junior faculty. Recurrent training is especially critical in the sciences, engineering, and arts because rapid technological changes require faculty to acquire new competencies to continue to be productive scholars.

4.2   Research training opportunities

Opportunities to learn new research skills and techniques via workshops, mini-conferences, short courses, or research training "camps" should be encouraged and supported.

4.3   Non-research-related professional development

It is important to recognize that faculty and administrators may benefit from participating in workshops, conferences, and communities of practice not directly related to their research. Institutions that support travel to non-research meetings provide career and professional development that also can enhance undergraduate research. Some examples include pedagogical techniques that can be applied to undergraduate research, such as project-based learning or course-based undergraduate research experiences (CUREs); diversity training that allows faculty to become more effective at supporting and mentoring students of a variety of backgrounds; training on how to purposefully implement and assess undergraduate research programs; and how to map undergraduate research experience to benefit the world of work.

4.4   Mentorship training

Over the last four decades, it has become evident that the success of undergraduate research, scholarship, and creative inquiry is highly dependent on the effectiveness of the relationship between the student and the faculty research mentor. While students derive multiple benefits from the relationship with an effective mentor (e.g., skill development, career guidance, sponsorship, emotional support, role modeling), the mentor also derives immediate and long-term benefits, such as a sense of personal satisfaction in witnessing the growth of future researchers, increased productivity of their research agenda and future collegial and professional relationships. Best mentoring practices have been identified and documented and may be reflected upon through mentor training, where experiences are shared with other mentors. Institutes, organizations and projects (e.g., the National Research Mentoring Network, CIMER, the University of New Mexico Mentoring Institute) provide a number of resources and mentor training programs.

4.4.1. Faculty

Mentor training is a good area for collaboration between the undergraduate research office, the faculty development office, and externally funded undergraduate research support programs, and offices, departments, or centers. Ongoing opportunities for faculty to reflect on their mentoring skills must include cultural humility, implicit bias awareness (includes stereotypes and micro-aggressions), bystander training (specifically how to effectively respond to bias), as well as, other inclusive practices. Discussions of mentoring issues between colleagues and framing student experiences for their next steps are essential to providing a student-centered research experience. Undergraduate research programs are encouraged to offer orientation sessions for mentors that clearly outline faculty, student, and program expectations and other best practices. Faculty should be encouraged to attend professional development meetings on mentoring, diversity, equity, inclusion, and leadership development. Faculty should also be encouraged to draft individual professional development plans. Junior faculty should be mentored by more experienced peers as they begin to juggle the potentially competing demands of teaching, service, scholarship, and mentoring of undergraduates.

4.4.2   Graduate students and postdoctoral fellows

Recognizing that at some institutions, graduate students and postdoctoral fellows play a significant role in mentoring undergraduate researchers, appropriate training opportunities should be provided to enhance their skills and ensure undergraduates are receiving excellent mentoring. This is critical because many of these graduate students and postdocs will eventually assume faculty positions and become the next generation of faculty mentors.

5. Recognition

An institution that values undergraduate research as a high-priority activity that is integral to its educational mission will provide clear, tangible forms of recognition for faculty and students who engage in it.

5.1   Promotion and tenure guidelines

If undergraduate research is an important institutional activity, it should be clearly and prominently described in promotion and tenure guidelines for faculty. Many institutions specifically identify mentoring, faculty-student collaborative research, and publication of student co-authored peer-reviewed research as especially valued activities for promotion and tenure. Understanding that using innovative pedagogy, such as project-based learning and course-based undergraduate research experiences (CUREs), can sometimes result in lower student evaluations initially, the department should have clearly stated policies related to the use of student evaluations for tenure and promotion, and how to account for temporary dips in student evaluations when implementing student-centered pedagogy. To be effective, promotion and tenure guidelines must be clear and effectively communicated to new faculty and to new members of tenure and promotion committees or faculty evaluation teams.

5.2   Salary review

Likewise, undergraduate research activity and productivity should be recognized in faculty salary reviews and decisions on merit pay awards.

5.3   Campus awards

Institutions with exemplary undergraduate research programs recognize and publicize the importance of undergraduate research through public awards for excellence. Programs and departments that provide outstanding undergraduate research experiences for students should be recognized. Examples of recognition include but are not limited to awards for excellent faculty mentoring, outstanding undergraduate research theses, prize-winning student publications, and outstanding research posters.

5.4   Prominent publicity for research accomplishments

Excellent undergraduate research programs promote their successes by prominently featuring examples and the impact of undergraduate research on the institution's website, in its print and electronic publications, and in its outreach to the public and social media. In addition, students involved in undergraduate research may be encouraged to apply for prestigious scholarships and graduate fellowships, and any such awards should be widely publicized. Wide publicity should also be given to any awards that faculty receive from professional societies and any awards received by students at professional meetings. Appropriate infrastructure and administrative support are required to identify successes and utilize germane publicity outlets.

6. External funding

External funding is essential for the development of a rich, productive, and cutting-edge faculty-student research environment. Although the availability and importance of external funding for research varies by discipline and sometimes by state and region, an institutional culture of supporting and encouraging the acquisition of external research funding is important to sustain research. Very few institutions have sufficient resources to sustain a viable research program with internal funding alone. Rather, institutions and faculty must partner to leverage internal funding with external funding to sustain strong undergraduate research programs and infrastructure over the long term. It should be emphasized that competitiveness in external funding is directly related to research productivity, that is, the production of peer-reviewed research scholarship. External funding comes with increased expectations for the dissemination of peer-reviewed projects. To sustain an excellent undergraduate research program, institutions must provide an environment in which faculty have the time necessary to meet the increased expectations for publication or other recognized types of dissemination.

6.1   Faculty research funding

In successful undergraduate research environments, faculty members seek and receive external funding to help support undergraduate research students, research technicians, graduate students, and/or postdoctoral fellows, and also to acquire research equipment and infrastructure. Although many research grants may be used, in part, to support undergraduate research, there are grant programs specifically designated for undergraduate research and for predominantly undergraduate institutions. Examples at the federal level include the National Science Foundation's Research in Undergraduate

Institutions (RUI) and Research Experiences for Undergraduates (REU) programs, as well as the National Institutes of Health's Academic Research Enhancement Awards (AREA, or R15), Research Education Programs through various institutes (REP, or R25) and the Research Initiative for Scientific Enhancement - Undergraduate (RISE-U). The McNair Scholars Program from the U.S. Department of Education specifically funds undergraduate research opportunities in all disciplines for under-represented, first-generation, and financially needy college students. Some private foundations (e.g., the Research Corporation for Science Advancement, the American Chemical Society Petroleum Research Fund, Mellon Mays Undergraduate Fellowship Program, the Howard Hughes Medical Institute, and the Camille and Henry Dreyfus Foundation) are specifically funding to support research with undergraduates. Especially in disciplines in which research infrastructure is critical for high-quality research, external funding is essential for creating and maintaining a strong teaching and research environment.

6.2   Institutional funding for research
Individuals committed to undergraduate research will also seek and receive institutional funding to support it. Some institutions dedicate funds from their student employment opportunities program to support students engaged in undergraduate research.

7. Dissemination
An essential element of all research is dissemination. Peer-reviewed publications, juried art and performances are often viewed as pinnacle dissemination. All public dissemination, albeit virtually, on-campus, for community partners, or otherwise, should be institutionally advertised and celebrated.

7.1   Peer-reviewed publication, exhibition, or performance
With an emphasis on process, CUR defines undergraduate research as a mentored investigation or creative inquiry conducted by undergraduates that seeks to make a scholarly or artistic contribution to knowledge. As such, research results should be disseminated in a form that is appropriate for a scholar in the field; the highest level of dissemination of undergraduate research is in the form of peer-reviewed publication, conference presentation, exhibition, or performance. In science, technology, engineering, mathematics, and medicine (STEMM) or the social sciences, for example, this would typically mean a published article in a peer-reviewed journal or an oral or poster presentation at a conference. In this instance, when students contribute significantly to the project, they should be included as co-authors and should be involved in the writing and editing of the manuscript. In the arts or humanities, dissemination might be a juried exhibition, public performance, or publication. Preparing students for research dissemination also provides an excellent opportunity to discuss the ethics of co-authorship. It is important that faculty and students strive for this level of scholarship because it typically provides the greatest intellectual benefits for students and is essential in faculty reward structures and for faculty seeking external research funding, especially at institutions where conducting research is one of the criteria used for promotion. Even as community colleges move more in the direction of integrating research into the curriculum or engaging students in summer research programs, publications, and exhibitions become very impactful experiences.

7.2   Presentation at professional meetings
Professional research meetings provide excellent opportunities for students to present research to other scholars in the field, gain feedback on their work, conduct professional networking (especially for seeking entry into graduate programs and/or internships), and try out presentations of research results prior to peer-reviewed publication. Institutions should endeavor to have policies and funding to encourage students' participation in such activities. Students who attend professional meetings, either virtually or in-person, should receive mentoring on how to navigate such opportunities, as well as connecting these experiences to advanced degrees and career readiness competencies.

7.3   Student research conferences
Not all undergraduates are ready to present research results at national professional meetings, especially early in their academic careers. For such undergraduates, a student research conference (e.g., the National Conference on Undergraduate Research) or a regional disciplinary conference might be a more appropriate venue to gain valuable experience in presenting and disseminating findings, connecting with others in the discipline, honing professional skills and gaining feedback on their ideas. Institutions should encourage and support student participation in these conferences.

7.4   On-campus symposia
Most institutions with successful undergraduate research programs host on-campus research symposia that bring together the community of undergraduate scholars, their mentors (e.g., faculty, postdoctoral fellows, graduate students), staff, and the community at large in events that celebrate undergraduate research. These events provide opportunities for student-student, faculty-student and faculty-faculty networking and cross-disciplinary conversation. They are also excellent venues to distribute achievement awards in mentoring, publications with undergraduate co-authors and grant awards that involve undergraduate research training. Outstanding institutions promote broad student attendance so that more undergraduates may benefit from a research-rich environment and the opportunity to learn from their peers. A campus undergraduate research office that organizes such events may also offer other kinds of support, such as workshops on writing abstracts, on making and presenting a research poster, and on creating and delivering an oral presentation. This assistance may greatly enhance the quality of the campus or virtual event and provide multiple learning and professional skill-building opportunities for students.

8. Student-centered issues
Undergraduate research is fundamentally a student-centered activity that involves faculty mentoring. Institutions have a responsibility to highlight the educational and professional impact of the activity. As a high-impact practice, faculty and administrative leaders should design undergraduate research experiences that are equitable and accessible, incorporate the best practices in undergraduate education, and highlight the connection to advanced degrees and career readiness competencies such as those detailed by the National Association of Career and Employers (NACE). Relevant issues include, but are not limited to, providing multiple opportunities for all students to engage in undergraduate research experiences within and beyond the physical and virtual classroom, high expectations for the student, an emphasis on ethical conduct in research, outlining paths to progress, assessing student development, connecting the research topic to societal and community issues, and demonstrating the benefits of undergraduate research experiences for students' next steps. Awareness of how societal barriers and inequities impact the opportunities of some students must also be considered when designing and implementing an undergraduate research experience. Students should leave with both transportable skills and products that provide leverage and momentum for their next step.

8.1   Opportunities for early and sustained involvement
Departments and programs should have mechanisms to identify and equitably recruit undergraduate researchers early in their careers. Assessment data indicate that undergraduates make the most intellectual gains and have the greatest opportunity for becoming research partners and co-authors of peer-reviewed publications, if they are involved in faculty-supervised research early and repeatedly in their academic careers (Lopatto 2009; Mieg, Ambos, Brew, Galli, and Lehmann, 2022), and if they are invited to make long-term commitments to research. Early involvement also helps students acquire multiple research experiences during their undergraduate years, and this may help them hone professional skills and define their career interests. Equally important is building robust pathways for transfer students, online, and adult learners to engage in sustained experiences within and beyond the classroom. One way to provide early and equitable access to research is to embed course-based undergraduate research experiences (CUREs) in lower-division courses and in required courses. Additionally, pursuing strategic partnerships with offices, centers, or programs that serve first-generation, historically underrepresented, and excluded minority students would alleviate potential delays in awareness and access to research opportunities. These partnerships also signal to students that inclusive practices are a priority in the research setting.

8.2   Establishing and communicating expectations
Faculty mentors should set high, clear, and realistic expectations for students engaged in undergraduate research. Such expectations might include, but not be limited to, the level of independent work expected, the minimum number of hours per week devoted to research, the minimum length of the research commitment (e.g., one semester or a full academic year), periodic and final oral presentations, a final report in a disciplinary-specific format, or other evidence of regular research progress, as well as articulated and transparent connections of their experiences to the world of work. Such expectations should recognize the many demands on students' time but should nevertheless encourage students to expand their engagement. Faculty should have regular discussions with students to provide feedback on their progress and revise expectations as needed. Recognizing that excellent mentoring

involves two-way communication about expectations, students should be encouraged to develop academic and career goals and discuss those with their research mentor, so that the mentor can advise/assist the student, follow-up periodically on progress and adjust as time progresses.

8.3 Developmentally appropriate expectations and intellectual ownership

Excellent undergraduate research environments provide opportunities for students to become involved at different points along the developmental pathway. First- and second-year students may begin engagement by performing duties that assist faculty or other members of a research team, becoming accustomed to the culture of research and learning skills along the way. Students may also begin by working on a project designed by a faculty mentor or one that is a continuation of another student's project. At the more advanced end of the developmental pathway, students may conceive their own projects based on the relevant literature and take full ownership of the projects. All points of engagement offer valuable experiences for students. Faculty mentors should encourage students to increase their levels of involvement over time, and programs should be structured to allow students to advance along a developmental continuum. Students should be informed about differing levels of engagement and development, and, as milestones are achieved, students should be provided with the knowledge to be able to assess their own progress, and articulate their learning and transferable professional skills gained. Institutions may wish to clearly label programs, courses, and student outcomes as "beginning, intermediate, and advanced." Well-designed undergraduate research experiences allow students to take increasing intellectual ownership of their research projects as they become acquainted with relevant research methodology. Students can and should be offered choices of appropriate research projects and be allowed to contribute intellectually to the work. Further, the creation of appropriate products aligns with a reparative model for critical mentoring (Longmire-Avital, 2020b), that reviews student signature work as an essential outcome for crafting an equitable and inclusive undergraduate research experience for first-generation, historically underrepresented and excluded students from minority groups. Aiming for a publication or conference presentation is common but not exhaustive of the types of products that students can produce. The signature work should reflect student interests and support the next steps in their academic or professional journeys.

Guidelines and expectations for sharing scholarly credit with students should be available for students and faculty. Campus policies should establish and clearly articulate how issues such as authorship and intellectual property rights, as well as ownership of data, will be handled. One excellent way to make those guidelines and policies available to students is through responsible conduct of research workshops.

8.4 Community of student scholars

Peer-to-peer interaction in the context of a community of undergraduate research scholars provides opportunity for student learning, for exploration of research and academic disciplines beyond their own experiences, understanding how the skills, knowledge and dispositions learned are transferable to next steps and for establishing an inclusive equitable environment that promotes diversity. Having a critical mass of students involved in undergraduate research makes it practical to develop opportunities for peer mentoring, regular disciplinary and interdisciplinary research seminars, research group meetings, and professional development workshops for students—either virtually or in person. A broad commitment of faculty at the department or program level is necessary to provide sufficient student research opportunities to build such a diverse community of student scholars. Institutional support, such as through an office of undergraduate research and institutional partners, such as career services, facilitates the development of peer-to-peer interactions.

8.5 Peer mentoring and teamwork

An important outcome of having a critical mass of undergraduate researchers and of their early and sustained involvement is the building of research teams with varying levels of experience or different disciplinary backgrounds. Such teams allow for peer mentoring opportunities that are important for intellectual and professional development. Research teams also allow multiple students to share a single research project, with each team member being responsible for a specific part. Institutions can consider providing funding for student assistants/peer mentors for courses with CURE elements. Pursuit of teams should also include clear plans for diversity, equity, and inclusion training. Specifically, training that centers on implicit bias and

micro-aggression prevention and reduction. The use of peer mentoring and teams also generates an opportunity to partner with research students and labs at other institutions, which would expand the perspectives and voices in the research experience. Teams and peer mentoring are student-centered; however, this approach generates an opportunity to nurture peer mentorship opportunities among colleagues either at the same or another institution. This may be a critical level of support for first-generation, historically underrepresented minority students and faculty when engaging HBCUs (Historically Black Colleges and Universities), MSIs (Minority Serving Institutions), and/or other institutions that are not considered predominately White.

8.6 Expanding and integrating student research opportunities with other engaging experiences

Institutions that strive for excellence should recognize and embrace opportunities to combine undergraduate research with other engaging experiences when students have achieved a level of research competence and self-efficacy. Opportunities for students to participate in research projects with different mentors, with an interdisciplinary team, or in projects that draw upon multidisciplinary practices provide expanded learning and experience. Opportunities for students to conduct research abroad, in a structured program, as part of a global team, or as an independent study are increasingly common. Students and their faculty mentors should be encouraged and supported in finding ways to apply their research through community-based research with service-learning programs, in exploring entrepreneurial applications, and in considering policy implications. Students who conduct research should be expected to be able to communicate the results of their projects and the transformational nature of their experiences to citizens, public leaders, and recruiters. Opportunities for students to articulate their experiences beyond the academic community and for various audiences are the hallmark of a mature undergraduate research culture and can be illustrated with events such as state capitol days, community presentations (e.g., to chambers of commerce and tourism boards), podcasts, museum exhibits, docent-led tours, as well as in interviews and with talent recruiters.

8.6.1 Capstone courses

When thinking about combining HIPs, infusing undergraduate research, scholarship, and creative inquiry (URSCI) in Capstone courses is a logical and easy fit. The infusion of URSCI in the capstone can be implemented using various frames, including team-based, community-based, or individual projects. As a culminating experience, this course also provides a great opportunity to surface and highlight the connections between the skills, knowledge and dispositions gained through the URSCI process and career readiness competencies. An added benefit of leveraging these two high-impact practices together is the accessibility created by infusing URSCI into the curriculum.

8.6.2 Study abroad

Bringing together global education and undergraduate research experiences can be a very powerful combination. URSCI experiences abroad create the opportunity for exposure to and implementation of different methodological and theoretical approaches, cross-cultural comparisons and syntheses, expansion of professional networks, and cultural exchange. While the benefits are many, there are some special considerations to reflect upon, including potential cultural and language barriers, data rights and transfer, import/export controls, material transfer, personnel security risks, political volatility, differing international and in-country laws relative to intellectual property, copyright, patents and commercialization, research with human and animal subjects approvals, and research sponsorship. Relationships with in-country host institutions, faculty, and consortia can help bridge gaps and navigate opportunities. The cost of research opportunities abroad is often a consideration, and attention should be given to exploring scholarships and partner opportunities within and beyond the institution to ensure access and equity in opportunity.

8.6.3 Research internship

As the national focus on internships increases, considering the value of research internships in industry or government entities can be a powerful component of a comprehensive undergraduate research program. Developing partnerships with local, regional, national and international industry, government, and research facilities can provide valuable work-based learning experiences. For smaller programs, leveraging existing networks can offer increased student opportunities and sometimes provide funding to expand access and opportunity.

Faculty need to be directly accessible to students when conducting research in collaboration with or under the faculty member's supervision. This availability allows students to engage in discussions that can range from the research itself to academic, career, and even personal matters, allowing the mentor to switch roles as coach, sponsor, or counselor. In turn, a student will feel included and develop a sense of belonging to a community of practice.

8.6.4 Community engagement

Combining undergraduate research with community engagement has the advantage of developing students with a deeper sense of purpose and a better understanding of their communities and their roles as citizens, while collaborating with individuals at the partner organization who may act as co-mentors. Partners may be from the public sector (city, county, state), the business sector, or a philanthropic organization, with many being health organizations. This equitable and collaborative approach must recognize the unique strengths that each academic and community partner brings. Research shows that the best partnerships are those in which the community partner is allowed to decide what the research question or focus will be, while recognizing that the project should enhance the faculty member's teaching credentials and/or producing co-authored publishable results. Simultaneously, faculty and community partners should ensure that undergraduates involved in the research project have a valuable learning experience that leads to the implementation of a solution to a community problem. Very often, projects involve engagement with historically marginalized and oppressed groups to generate transformative change in communities. Undergraduate students should be encouraged to reflect often on the experience's impact on their perception of their values as citizens.

Within academic institutions, these community-based participatory research projects present excellent opportunities for collaborations between undergraduate research offices, centers of community engagement and faculty members with the aim of combining knowledge with action to achieve social change. Effective collaborative partnerships develop a vision to grow gradually by conducting a series of short-term projects to achieve long-term goals.

9. Curriculum

Departments and programs should design curricula that expose students to skills necessary to undertake undergraduate research, and curricula should be designed in ways to facilitate and scaffold faculty and student involvement in undergraduate research.

9.1   Research-supportive curricula

Institutions that highly value undergraduate research have departments and programs that are careful to design curricula to be supportive of research. Some basic principles are articulated here. CUR has compiled many specific examples of research-supportive practices (Karukstis and Elgren 2007).

9.1.1 Content

Successful and sustainable disciplinary or interdisciplinary undergraduate research programs are buttressed by a curriculum that provides students with the necessary training and methodology for them to be successful in the research environment. Research-supportive curricula also build in experiences that provide scaffolding for undergraduate research, allowing students to acquire and practice transferable skills that can be later applied to independent or faculty-student research as well as in their careers. A research-supportive curriculum will expose all students to the importance of research and research ethics and result in students gaining an appreciation for research methodology in their area of study, even if they do not participate in undergraduate research.

9.1.2 Integration of teaching and research

A powerful method of undergraduate education is the integration of teaching and research through course-based undergraduate research experiences (CUREs) or authentic learning experiences (ALEs). CUREs provide opportunities for students to develop knowledge that is new to the discipline (authentic research), whereas in ALEs, students develop knowledge that is new only to them. For example, teaching laboratory techniques in the sciences through a CURE, typically assigns students portions of real research projects in which the requisite coursework, techniques, and skills will be encountered. Under the right conditions, students participating in CUREs may become legitimate co-authors of peer-reviewed publications due to their contribution to the research project. In some disciplines, particularly in the humanities and engineering, themed senior seminars and capstone courses provide opportunities for faculty to mentor high-caliber research projects

that may be disseminated at professional or undergraduate research meetings.

Integration of teaching and research is a very inclusive practice that broadens participation and increases student engagement. The practice helps recruit students for participation in other undergraduate research projects, allows faculty to build research supervision into their teaching load and often results in higher productivity for the faculty member. To achieve these kinds of experiences, faculty and departments need to think creatively about what courses they must offer and be open to offering courses on special topics that allow for the integration of research experiences. Administrators should be encouraged to support CUREs.

9.1.3 Course scheduling and managing faculty teaching loads

Undergraduate research requires a significant commitment of time by both faculty members and students. Faculty need to be available during the academic year to mentor undergraduates and also, depending on their field, to conduct research on their own. Toward this end, both the quantity and quality of faculty members' teaching loads should be carefully managed to allow sufficient time during the week for faculty-student interaction. Department chairs and program directors should endeavor to create blocks of time for faculty to devote to supervising undergraduate research, for example, ensuring that one day per week or each afternoon is free of classes. In addition, whenever possible, it is desirable to assign multiple sections of one course rather than multiple courses when designing a faculty member's teaching load. Such considerations are important as a CUR survey revealed that faculty members were decreasingly satisfied with their ability to sustain productive faculty-student research beyond nine contact hours of teaching per week (Wenzel 2001).

9.2   Additional training opportunities and workshops
9.2.1 Training in responsible conduct of research

All undergraduate students should be instructed in the ethics of responsible research. This can be implemented within individual courses or programs, or the training may be conducted campus-wide. Additional opportunities for training in the responsible conduct of research should be provided for summer research students. Funding agencies have made training in research ethics a requirement for funding undergraduate researchers and ask that the training be face-to-face or virtually synchronous (not just online and self-paced) to encourage discussion. In addition to acquiring knowledge regarding research misconduct (fabrication, falsification, plagiarism, and fraud, students should be made aware of questionable research practices that do not necessarily constitute misconduct but that can jeopardize the integrity of projects and the commitment of stakeholders.

9.2.2 Professional and career readiness skills workshops

Undergraduate students should receive specific training in the appropriate oral, written and visual research communication skills, for example, writing research reports and papers; designing posters; giving an effective oral research presentation; applying for fellowships and graduate programs; applying for juried art competitions; networking at conferences; etc. This training may be incorporated in gateway courses for disciplinary majors, or it may be offered separately as training by undergraduate research offices, disciplinary departments, or research programs. Programs of excellence are also transparent in helping students articulate the valuable skills they are honing in their research experiences that employers seek in undergraduates. Faculty mentors are expected to discuss a variety of professional skills with undergraduates; however, programs of excellence will ensure that students have multiple opportunities to enhance their professional and career readiness skills.

A characteristic of excellence in undergraduate research is taking the next step to help students frame and articulate their research experiences in ways that potential employers will receive and understand.

9.3   Student course credit for research and other compensation

Whenever possible, institutions should have a mechanism to award course credit to students for participating in undergraduate research. In some cases, up to 25 percent of a student's normal semester course credit is awarded for research participation. In collaboration with faculty mentors, institutions should define prerequisites and expectations for awarding academic credit for research and scholarly projects. In addition, institutions and faculty should find funds to compensate students who conduct research during the academic year. This is particularly important for students who are financially disadvantaged and must work to help support themselves. For those students, working as undergraduate researchers replaces jobs that generally do not

develop the type of transferrable skills that undergraduate research provides and gives such students a stronger motivation to stay engaged in their academic pursuits.

9.4   Requiring undergraduate research

Some programs require all graduating majors to be engaged in research, during their senior year or at some other time. Ideally, these students should have the opportunity to be involved in long-term research projects with the potential to culminate in a significant written report or artistic demonstration that draws from the literature and contributes to the field. Students should also publicly disseminate this work via presentation or exhibition. Many institutions with strong undergraduate research programs require all students awarded departmental honors to conduct a long-term, intensive research project that results in a significant thesis or oral defense.

10. Summer research program

A robust summer research program is essential to a vibrant undergraduate research environment. For students, the summer months offer a time when they can concentrate exclusively on a research project. For faculty at more teaching-intensive institutions, the summer months provide the only time during the calendar year when they can focus their efforts exclusively on research. For faculty at all institutions, this is a time with fewer external and institutional commitments, and it can afford the opportunity for more intensive mentoring of undergraduates. Summer research programs must have an equitable model for providing support for participation. Summer is a time for some students to earn funds for the upcoming academic years. An inclusive and accessible research program needs to be attentive to student needs (e.g., housing, monetary support, transportation).

10.1   Research-supportive teaching calendar

In a supportive undergraduate research environment, faculty teaching responsibilities should not include the summer months. This is especially important at more teaching-intensive institutions, where the summer months are typically the most productive times for research. It is also important for institutions to avoid creating imbalanced incentives for summer teaching that serve as disincentives for involvement in research and scholarship.

10.2   Faculty compensation

Many institutions provide compensation to faculty to conduct summer research with undergraduates. This compensation can take the form of faculty stipends, course credit, and/or credit toward research leaves; in some instances, funding for research supplies may be provided in lieu of or in addition to faculty compensation. If institutions value faculty involvement in summer research with undergraduates, compensation for this activity must be competitive with conflicting activities, such as summer teaching.

10.3   Student compensation

Students should receive adequate compensation for conducting summer research. Ideally, compensation should be above the minimum wage. Typical summer stipends for a 10-week, full-time research assistantship supported by federal programs are $5,000 to $8,000. In some cases, students may receive academic credit for summer research in addition to a summer research stipend.

10.4   Student housing and access to facilities and student services

Attractive, on-campus student housing should be available to summer research students. Housing students on campus helps create an academic community of scholars during the summer months and facilitates summer research programming. Many institutions offer summer housing at no cost to students. Providing inexpensive, attractive summer housing helps recruit students to do summer research, especially when other job opportunities may be more attractive in terms of salary compensation. Access to facilities and services (library, computer center, student health and counseling centers, recreation center, food services, etc.) should be provided for summer research students.

10.5   Student programming

Institutions should devise mechanisms to bring the summer research community together for common activities, including purposeful interaction between faculty and students. In addition to social activities, educational activities for students should include professional development and career workshops, ethics training, and speakers on research areas and careers. The summer is an ideal time for training activities that can be done in smaller, focused groups; this may include journal clubs, training in technical skills or data analysis, and introduction to new research approaches.

10.6   Summer research symposia

Students should have the opportunity to present the results of summer research to their peers and to faculty and administrators. Typical venues include poster sessions, oral presentations, performances, or exhibitions. Events can be formal or informal and may be scheduled at the end of the summer or at the beginning of the fall semester. Summer research symposia provide students with opportunities to learn discipline-specific dissemination practices, receive feedback on their work, and hone career readiness skills. They also allow the campus community to celebrate the students' work. Campuses can use these opportunities to engage the students' families, whenever possible, and the broader community beyond the campus. This is especially important for first-generation college students.

10.7   Coordination among multiple programs

When a campus is host to a number of summer programs (e.g., multiple NSF (National Science Foundation) or NIH REU sites, department programs, McNair programs, etc.), institutions that aspire to excellence will coordinate programs and collaborations on appropriate activities. Not only does such coordination and collaboration result in efficient use of resources and encourage the sharing of best practices among programs, but students also benefit from interaction with peers in other disciplines. Offices of undergraduate research, when available at the institution, are an ideal place to centralize the coordination of such activities.

10.8   Hosting visiting students

Many summer programs host undergraduates from other institutions to expand the reach of their program and diversify their summer research community. When visiting students are part of the summer undergraduate research program, several types of support should be available:

- An orientation to the campus, community, and program should be held. Information on safety and security issues and information about student services should be covered in the orientation (e.g., tornado safety, night-time security, student health center, counseling center).
- Students should have multiple points of contact available to address any concerns about the program, their housing arrangements, emergency situations and illness, and personal situations. Institutions should pay special attention to how it provides access to student health, counseling, and Title IX services to the visiting students. Contact information for additional faculty or staff beyond their research mentor should be available.
- Activities designed to encourage interaction between visiting students and native students should be arranged.
- Thought should be given to the student experience "after hours," on weekends, and during holidays when students are not engaged in their research. This is especially important for students without their own transportation or who are spending the summer in an unfamiliar environment.
- Housing and meal accommodations should be arranged in advance for visiting students, and their needs for transportation to campus or the research site (if needed) should be addressed. Students should be made aware that members of the residential-life staff are available to provide assistance.
- Logistics support for registration, housing, payment of stipends, and other fiscal administration should be provided so that visiting students and faculty mentors do not need to navigate the fiscal issues without assistance. Insurance and liability issues should be considered.
- Faculty members mentoring guest students should understand their responsibilities and the program's goals and have contact information.

11. Assessment activities

Institutions and programs of excellence will have multiple approaches to assessment to recognize successes, illuminate gaps, and collect benchmarking data. Assessment plans should be appropriate for the context and purposeful in design.

11.1   Assessment of student learning

Research studies demonstrate the value of undergraduate research experiences on learning and student growth. Undergraduate programs and faculty mentors ought to consider the student learning outcomes of undergraduate research and develop a plan to assess the effectiveness of their program in meeting these learning outcomes and mapping them to career readiness skills (Lopatto 2009; Mekolichick 2021; Mieg, Ambos, Brew, Galli, and Lehmann, 2022).

11.2   Program assessment and evaluation

Assessment of student learning outcomes is important; however, exemplary undergraduate research programs will go beyond this and collect assessment and program-evaluation data that will take into consideration and include:

- a mechanism to obtain feedback from students and faculty on their satisfaction with logistical operations and program activities
- a sustainable method to collect data on the number and demographic variables of students who participate in undergraduate research (both through co-curricular faculty mentoring or through the curriculum such as in CUREs), the level of their engagement, and outcomes resulting from
- their participation (presentations, attendance at off-campus conferences, publications, etc.)
- a sustainable method to collect data on the efforts of faculty mentors and outcomes resulting from their work with undergraduates (co-authored publications)
- a mechanism to track external funding that directly or indirectly supports the undergraduate research enterprise
- a mechanism and encouragement for students to report on post-graduation educational and career plans related to their undergraduate research experiences
- resources (personnel, software to create databases and surveys, encouragement for students and faculty to respond to queries, etc.) to develop and sustain assessment and collection of benchmarking data.

Collection of benchmarking data should be institutionalized, and implementation, therefore, will best succeed with broad support from campus leadership and faculty; expert assistance from the registrar and institutional research; and collaboration with academic, student, career and alumni affairs offices. Implementation of an effective assessment and data-collection plan cannot be the sole responsibility of the designated undergraduate research program coordinator/director. Additionally, collected information must be disseminated to key stakeholders annually. Assessing the impact of undergraduate research participation on students' academic outcomes at an institutional level is possible through coordinated efforts between undergraduate research offices and institutional research offices when there is a reliable mechanism to track student participation (Battaglia 2022).

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No Excellence without Equity: The Case for Rebuilding Undergraduate Research on a Foundation of Equitable Mentoring

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Differential Impacts and Equity Gap

Decades of research have shown that the benefits of participating in undergraduate research (UR) are most pronounced for students from racially and ethnically minoritized groups and for first-generation and Pell-eligible students. Yet access to UR continues to favor White, continuing-generation students with socioeconomic privilege, and the equity gaps have only been widening (Carpi et al. 2016; National Academies of Sciences, Engineering, and Medicine 2019; Zilvinskis et al. 2022). A nexus of persistent racism and well-meaning but biased responses is to blame. This chapter calls for dismantling the problems and rebuilding UR on a foundation of culturally responsive, equitable mentoring.

Persistent Racism

When minoritized students access UR, they risk contending with discriminatory assumptions of mentors and peers in mostly White spaces. Macroracism is devastating. Subtler microaggressions, misalignment between identities and expectations, and regular reminders of bias are also significant, often traumatic barriers (Beals et al. 2021; Longmire-Avital 2018; Mendoza and Louis 2018).

Universalism

"Equal" is not equitable. Claiming that UR is open to "all students" equally, without noting disparate outcomes, is a universalist ("all lives matter"), "color-blind" approach. Refusal to "see color" is refusal to recognize or address racialized disparities. Insisting that every student has equal access to UR rejects the facts and is a form of gaslighting.

Diversity Head Counts

Those attending to racialized inequities in UR sometimes arrive at misguided fixations on the compositional diversity of participants (i.e., head counts). They may recruit minoritized students without learning what students find valuable and meaningful—without doing the "inclusion" part of diversity, equity, and inclusion (DEI).

Whiteness

With a majority of White faculty, White students often have an unfair advantage because researchers tend to choose collaborators with similar identities, a phenomenon known as the similar-to-me effect ("Similar-To-Me Effect" 2024). A lack of representation in research, when researchers tend to choose collaborators with like identities (the similar-to-me effect), becomes a repetitive cycle, as minoritized students are less likely than White peers to learn about UR and therefore less likely to pursue doctoral study and become academics (Peifer 2019; Pierszalowski, Bouwma-Gearhart, and Marlow 2021; Rodríguez Amaya et al. 2018; Vieyra et al. 2013).

Students with high GPAs who signal enthusiasm and time for research get invitations to join research teams (Shanahan et al. forthcoming). But selecting students based on their previous successes and eagerness affects reifies privilege and perpetuates inequity. It rewards Whiteness and socioeconomic privilege, not ability or potential.

A Foundation of Equity

Although much about UR has changed since the first *Characteristics of Excellence in Undergraduate Research* publication, a defining feature remains: effective mentoring is essential to positive outcomes (Linn et al. 2015; Monarrez et al. 2020; Vandermaas-Peeler, Miller, and Moore 2018). Culturally responsive mentoring is the most salient factor in minoritized students' success (Healey and Stroman 2021; Johanson, DeFreece, and Morgan 2022; Kendricks, Nedunuri, and Arment 2013; National Academies 2019). Whereas changes to policies can get more diverse students involved, the mentor relationship most significantly characterizes students' experience in UR, positively or traumatically (Beals et al. 2021; Monarrez et al. 2020).

Racially and culturally responsive mentoring can mitigate barriers and create safe and brave UR spaces (California State University n.d.; Mendoza and Louis 2018; Mondisa, Packard, and Montgomery 2021; Pierszalowski et al. 2021; Wofford et al. 2023). Rather than merely tweaking inequitable practices, let us rebuild UR opportunities from a foundation of equitable, culturally responsive mentorship, which brings together theory, reflection, and practice.

Theory

Critical race theory (CRT) provides an evidentiary impetus to make major changes to UR praxes. CRT illuminates and challenges how race and racism intersect in shared values, policies, and practices—in the law, where it began, and in other societal and educational contexts (Crenshaw et al. 1996). A CRT approach examines the enormous costs to minoritized students of years of institutional and interpersonal racism. The resulting "racial battle fatigue" and isolation, especially on predominantly White campuses, are literally making Black, Indigenous, and other people of color (BIPOC) sick (Winters 2020). Learning about educational racism should never involve probing into students' personal traumas. Instead, it requires work like participating in equity-focused professional development; examining institutional research data about student success, disaggregated by identities; and reading DEI publications.

The community cultural wealth model of Yosso (2005), a CRT-informed means of challenging racism in education, applies well to UR. Limited—and limiting—definitions of merit employed to select student researchers will privilege White and wealthier students. Yosso's model guides recognition of the value of diverse students' cultural wealth: the aspirational, linguistic, familial, social, navigational, and resistant "capital" they bring to research and inquiry.

Reflection

Understanding theory is important for making change, although, especially for White people, acting without reflecting on one's own positionality within inequitable systems can offer a tempting and harmful bypass to White saviorship behavior. The study of theory and analysis of data must be layered with a humble and honest reflection on one's own personal and social identities and how those identities are visible and salient in various contexts (University of Michigan 2024). Through equity-focused reflective work, mentors can come to understand how their intersectional identities might affect different students' perceptions of and interactions with them. Theory and reflection are inextricable aspects of offering social and psychological safety and sharing power.

Practice

Equity-minded action emerges from continuous learning and reflection. Recommended resources for informed change-making include The Equity-Minded Mentoring Toolkit (Wofford et al. 2023); Advancing Inclusive Mentoring (AIM) (California State University n.d.); Ten Simple Rules for Building an Antiracist Lab (Chaudhary and Berhe 2020); and the Centering DEI in UR planning tool (McNair, Bensimon, and Malcolm-Piqueux 2020; REJI 2024).

UR mentors committed to equity can make change at every stage of student engagement. Culturally responsive mentoring is characterized by flexibility and awareness of students' lives "beyond the lab." Students historically excluded from UR report an insurmountable lack of time and financial resources. The competing demands of coursework, family responsibilities, and paid employment are often more pressing than UR's long-term benefits (Longmire-Avital 2018; Shanahan 2018; Vieyra et al. 2013). That is no excuse for moving on from students with economic constraints to those who can more easily participate. Paid and course-based UR opportunities are essential to broadening participation. Designing course-based undergraduate research experiences (CUREs) with attunement to power dynamics within the class brings in students who would not otherwise consider themselves scholars. Compensation is not the sole solution, however. Minoritized students need mentors who are creative and compassionate and who consciously strive to make connections between students' home lives and academia.

Conclusion

Mentorship is at the core of UR. But it also can be a source of microaggressions, macroaggressions, and educational trauma. Moderate adjustments have not closed opportunity gaps between minoritized and privileged students. To achieve excellence in UR, it is imperative to dismantle inequities and rebuild programs on a foundation of culturally responsive, equity-focused mentoring. At the intersection of theory, reflection, and practice, culturally responsive mentors can center minoritized students' aspirations and success.

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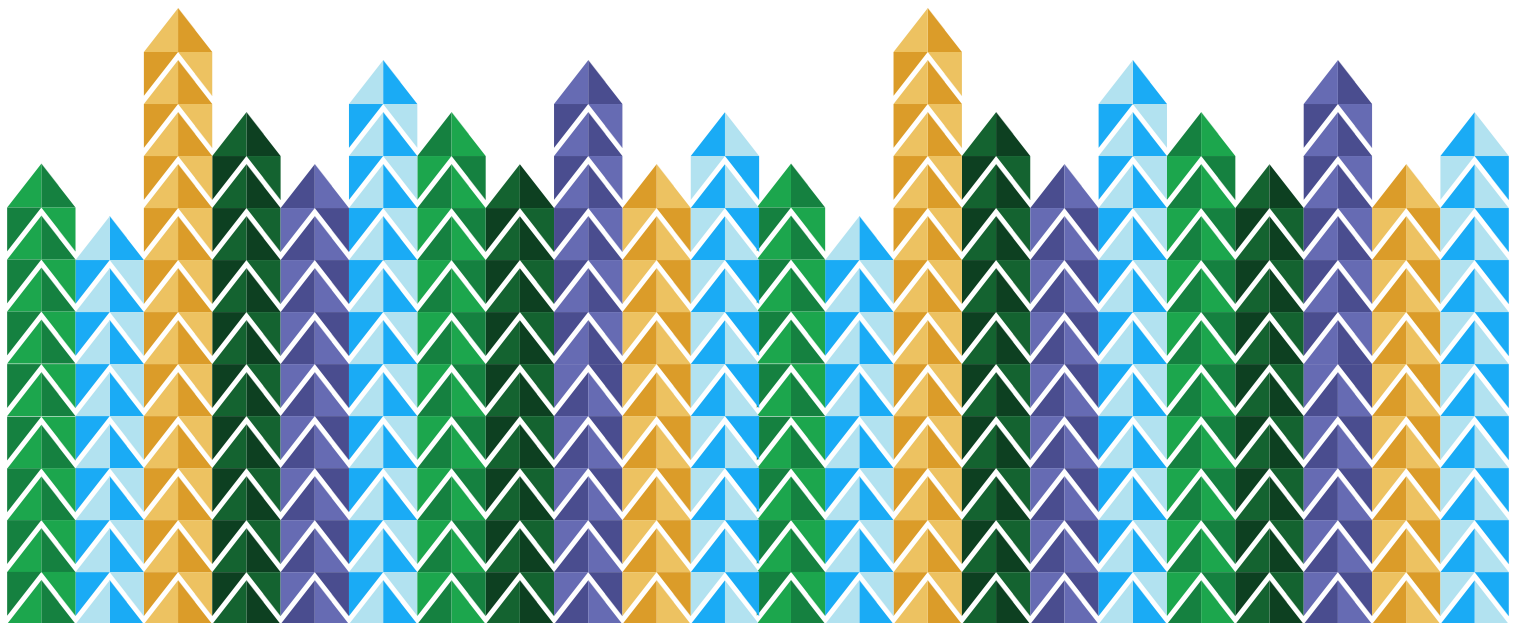
The Research Internship and Work-Based Learning

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Research internships are an integral part of a university's undergraduate research portfolio because they connect a student's discipline, its methods of inquiry, and the world after college or university. Undergraduate research has grown and developed as an idea and practice over the past four decades. Central to this movement is the definition of undergraduate research as a mentored investigation or creative inquiry conducted by undergraduates that seeks to make a scholarly or artistic contribution to knowledge (Council on Undergraduate Research 2024). This definition is inclusive, embracing a wide array of disciplines, methodologies, and settings, including internships. For some, this is a paradigm shift, but actually, it is another flavor of undergraduate research in the form of an internship. Clearly, not every internship is an undergraduate research experience, but many are, and have deep roots in academic methodologies, even though the project outcomes may be quite pragmatic. Understanding and recognizing these opportunities can enrich the student's portfolio of experiences.

A research internship typically has an external client or employer that pays the student to build or execute a project. A school's portfolio of traditionally sponsored undergraduate research experiences from grants or endowments are technically internships. A student gets paid for their work on a project in which they also are considered a novice in training. However, this experience often is not called an internship. These projects may vary from a history student doing research for a historical society, a sociology student researching an urban planning problem, or an art student preparing research for an exhibit at a museum. They also include business projects in which students employ research skills to address a business problem. Contrary to media reports, businesses provide internships and hire students from a range of disciplines based on "what they can do." Employers value not just the undergraduate experience, but the range of academic skills that are part of research and artistic experiences, including communication, independent inquiry, and creative thinking (Finley 2023). Ironically, many traditional business students could be counted in the undergraduate research program's annual tally but are overlooked because this connection between research and internships is not well recognized.

Because mentoring is a key aspect of undergraduate research, the research internship should include some type of mentoring. This may be on-site mentoring, delegated mentoring, or off-site mentoring. On-site mentoring happens when the faculty member also is employed by the organization the student is interning with. This is a common practice when a student is part of a consulting project conducted by faculty. A delegated mentor is often a student's supervisor or the internship coordinator at the company. Off-site mentoring may be a part of an internship in which the student "checks in" regularly with a faculty mentor. It might be combined with a delegated mentor at the company or organization employing the student. Regardless of the model, the research internship should have a mentorship component, in which the student has an adviser who can help them develop insight and contextualize their research experience.

The research internship should be a vehicle to success for the student and sometimes the faculty member. As a geographer, the author placed many students with private companies in the Chicago-Milwaukee corridor as well as government and nonprofit organizations using off-site and delegated mentoring models. Mentoring on-site as part of the project is always more exciting and interesting. Aside from working with students, one learns from industry why a discipline has value beyond its intrinsic worth in the undergraduate setting. Later in the author's career, when teaching in a business school, the research skills students developed in course-based undergraduate research experiences (CUREs) often were the basis for them getting a research internship as well as what made them successful. Often, students returned to campus with a job offer in-hand because of their research work at the company.

It is easier for some disciplines to engage with the business community, but most academic fields can find internship opportunities for students. Finding meaningful internships is not as challenging as it might seem. Collaborations between students, career services, and faculty can uncover research-oriented internships. Attending local meetings and lunches (chamber of commerce, civic organization meetings, local think tank presentations, etc.) allows faculty to network with organizations that have need of their students as research interns. Faculty can leverage their own networks, including professional meetings and local organizations, to connect students with these opportunities. One of the most successful professional organizations in this arena has been the Mathematical Association of America Preparation for Industrial Careers in Mathematical Sciences (PIC Math) program (Mathematical Association of America 2024). Using funding from the National Science Foundation and the Society for Industrial and Applied Mathematics (SIAM), the program works with faculty to make connections with industry and develop projects with companies. Regardless of discipline, getting out into the community and finding opportunities for students in businesses, government, and nonprofits does not have to be daunting. These approaches ensure that students have access to research internships that not only complement their academic pursuits but also provide valuable professional experiences.

It is important for offices of undergraduate research and administrators to recognize these diversified research experiences as part of their university portfolio. This shift allows for a broader understanding of what constitutes undergraduate research, giving value to the range and depth of modern undergraduate research endeavors. It also provides additional compelling stories to tell prospective students, parents, and friends of the university. It is less about comparing current practices to those from years ago and more about acknowledging the variety and impact of contemporary research activities by undergraduates. This recognition reflects some changing perceptions of what constitutes scholarly work, challenging the traditional boundaries between academic research and applied research.

Internships are increasingly important for postgraduate employment and provide valuable experience and skills transferable to future jobs. Often, they serve as extended job interviews, in which the work ethic and intellectual curiosity of the student are evaluated in a professional setting. As we continue to embrace and expand these inclusive definitions and practices, we enhance the academic and professional development of our students, preparing them for a dynamic and interdisciplinary world. This approach not only enriches the educational experience but also bridges the gap between academic learning and professional application, ensuring a more comprehensive and practical education for undergraduate students.

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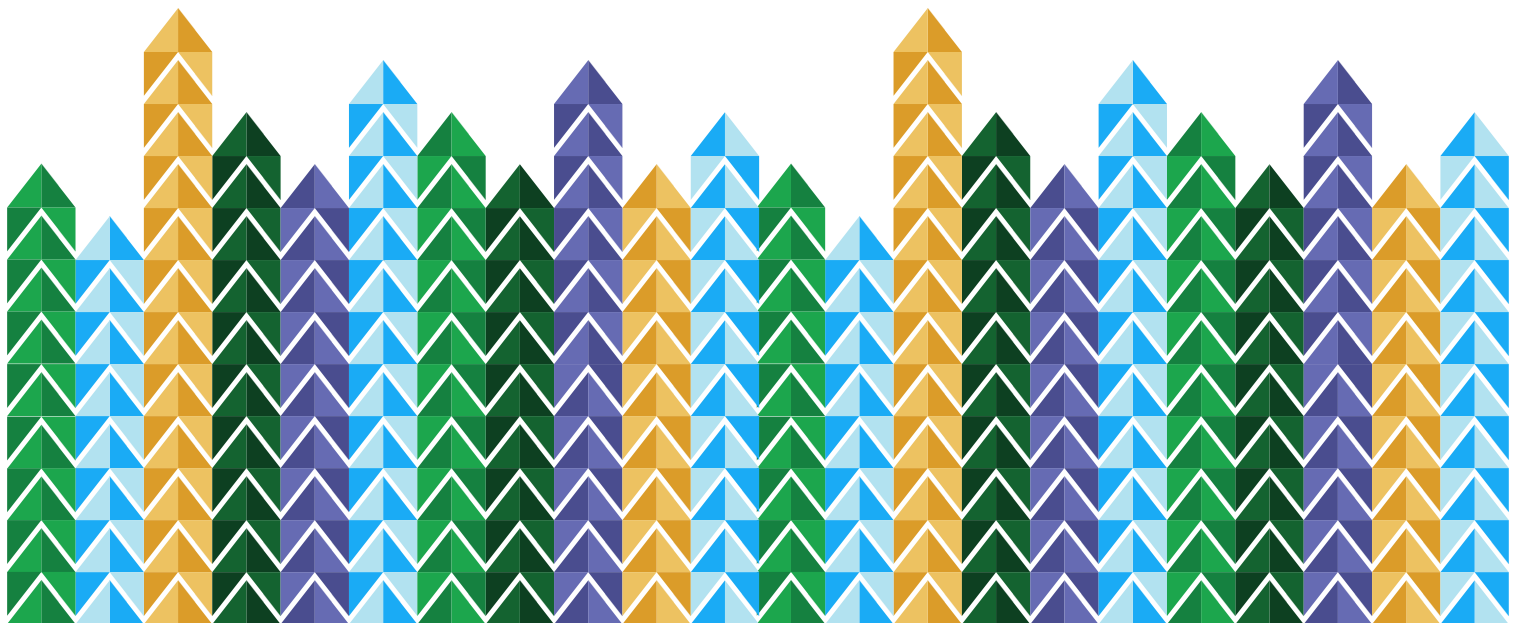
Development and Evaluation of Course-based Undergraduate Research Experiences (CUREs) Across the Disciplines

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This contribution provides a primer for individuals interested in adopting, developing, refining, and evaluating course-based undergraduate research experiences (CUREs) across both the STEM and non-STEM disciplines. In addition to defining the essential elements of a CURE, considerations for effective implementation and sustainability are discussed. The contribution concludes with several resources accessible to both novice and veteran CURE practitioners and scholars.

Definition

Although open forms of inquiry have been championed in K–16 learning environments for several decades (e.g., Chatterjee et al. 2009; Wang et al. 2022), the acronym CURE was first coined in a seminal report published by Auchincloss et al. (2014) in CBE–Life Sciences Education. In that report, the authors identified five key features of a CURE, which included the following.

- **Disciplinary practices.** This aspect of CUREs acknowledges the techniques, processes, and activities that scholars engage in to effectively and meaningfully study a phenomenon of interest. In the science, technology, engineering, and mathematics (STEM) fields, for instance, this encompasses tasks such as asking questions and generating hypotheses, gathering data, analyzing data using statistical approaches, and communicating findings using visualizations or models.
- **Collaboration.** Collaborative work is increasingly needed to address interdisciplinary and complex problems across a diversity of fields, ranging from the humanities and fine arts to business, STEM, and beyond (National Research Council 2011). Consequently, engaging students in collaborative work not only reflects authentic practices in the disciplines, but also exposes students to the importance and value of operating as a collective.
- **Iteration.** Research and creative endeavors are not "once-and-done" processes. Integrating iteration into your CURE—whether through opportunities for repetition, productive troubleshooting, learning from and addressing "failures," or pursuing future directions—is paramount to creating a space in which students are free to thoroughly explore the phenomenon in question.

- **Discovery.** Counter to "cookbook" curricula, which involve students completing a prescribed set of exercises with a known solution, a focus on discovery implies that the knowledge to be generated is novel to both the CURE students and instructor.
- **Broadly relevant or important work.** In tandem with the above feature of discovery, broader relevance implies that the work being conducted in the CURE has applicability and impact beyond the boundaries of the classroom. Auchincloss et al. (2014) note that this can be achieved through a variety of means, ranging from publications and presentations to policy initiatives and community-based efforts.

The latter two features have been argued to be unique features of CUREs (Brownell and Kloser 2015), although there has continued to be significant discussion of the conceptual and operational definition of CUREs by different instructors (e.g., Beck, Cole, and Gerardo 2023). Therefore, the above five dimensions should not be thought of as a checklist, but rather as a framework upon which to structure your CURE.

Implementation and Sustainability

First, you must consider the target audience for the CURE. Is it first-year students? Students from a single major or a diversity of majors? Students with previous research experience or those with none? Relatedly, who will be instructing the course? Research in the biology education space suggests, for example, that graduate teaching assistants often express greater concerns related to teaching a CURE than they do regarding a traditional laboratory course. They often receive little or no professional development to aide them in the CURE role (Kern and Olimpo 2023; Shortlidge et al. 2023). Knowing your team is an essential first step in determining how you initially adopt, adapt, or develop a CURE.

Practically speaking, you must also be mindful of the feasibility of the implementation of the CURE with respect to personnel, time, funding, and other resources. Several national CURE models exist, primarily in the STEM domains (e.g., the Genomics Education Partnership; Shaffer et al. 2010), which may be ideal for those new to CUREs because of the level of training and resources that they often provide. For those seeking to design an independent CURE, one based on their own research expertise or creative or scholarly interest (e.g., Dvorak and Hernandez-Ruiz 2019; Leyser-Whalen and Monteblanco 2022), identifying pedagogical and research-oriented goals for the course, determining how the key features of CUREs will be addressed, and developing a tentative schedule that includes resource needs for each week of the term are especially critical. Existing tools, such as the DoC IT (Olimpo and Kern 2021), can provide useful brainstorming templates for addressing these items.

Once an operational prototype for the CURE has been developed, it is strongly recommended that the course is piloted with a small subset of students (e.g., one or two sections of a multisection course). This will allow you to identify and resolve any issues associated with the CURE, refine course materials for future iterations, and outline strategies for equipping any additional instructors with the necessary knowledge and skills to execute the CURE with high fidelity (e.g., Olimpo, Fisher, and DeChenne-Peters 2016). Involving a neutral third party (e.g., the institution's center for teaching and learning) in this process may yield additional helpful insights. As one scales up and considers the sustainability of the CURE, it becomes important to determine how existing infrastructure (e.g., course fees, institutional commitment) can be leveraged to broaden student access and engagement. Consider also that scalability and sustainability are likely dependent upon a phenomenon to address that requires multiyear investigation or that the research focus of the CURE can evolve or rotate (e.g., a focus on marine ecophysiology but with a genetics lens the first year, a toxicology lens the second year, etc.). Lastly, strengthening and expanding your team through demonstration of the CURE's effectiveness will not only directly enhance interest but also ensure longevity, as the success of the CURE will not depend upon a single individual (Auchincloss et al. 2014).

Resources

CUREs are a potentially powerful mechanism for involving students in discovery-driven inquiry at scale (Auchincloss et al. 2014; Esparza, Hernández-Gaytan, and Olimpo 2023). In addition to those references cited throughout this contribution, both beginning and seasoned CURE practitioners will find additional support from the Research Corporation for Science Advancement's Expanding the CURE Model (Waterman and Heemstra 2018; free PDF available); the CUREnet website, where materials based upon

work supported by the National Science Foundation can be found (CUREnet n.d.); and the National Academies' Science of Effective Mentorship in STEMM (National Academies of Sciences, Engineering, and Medicine 2019). The latter is relevant to non-STEMM disciplines as well. For CURE teaching assistant professional development, see "Preparing Teaching Assistants to Facilitate Course-Based Undergraduate Research Experiences (CUREs) in the Biological Sciences: A Call to Action" (Shortlidge et al. 2023).

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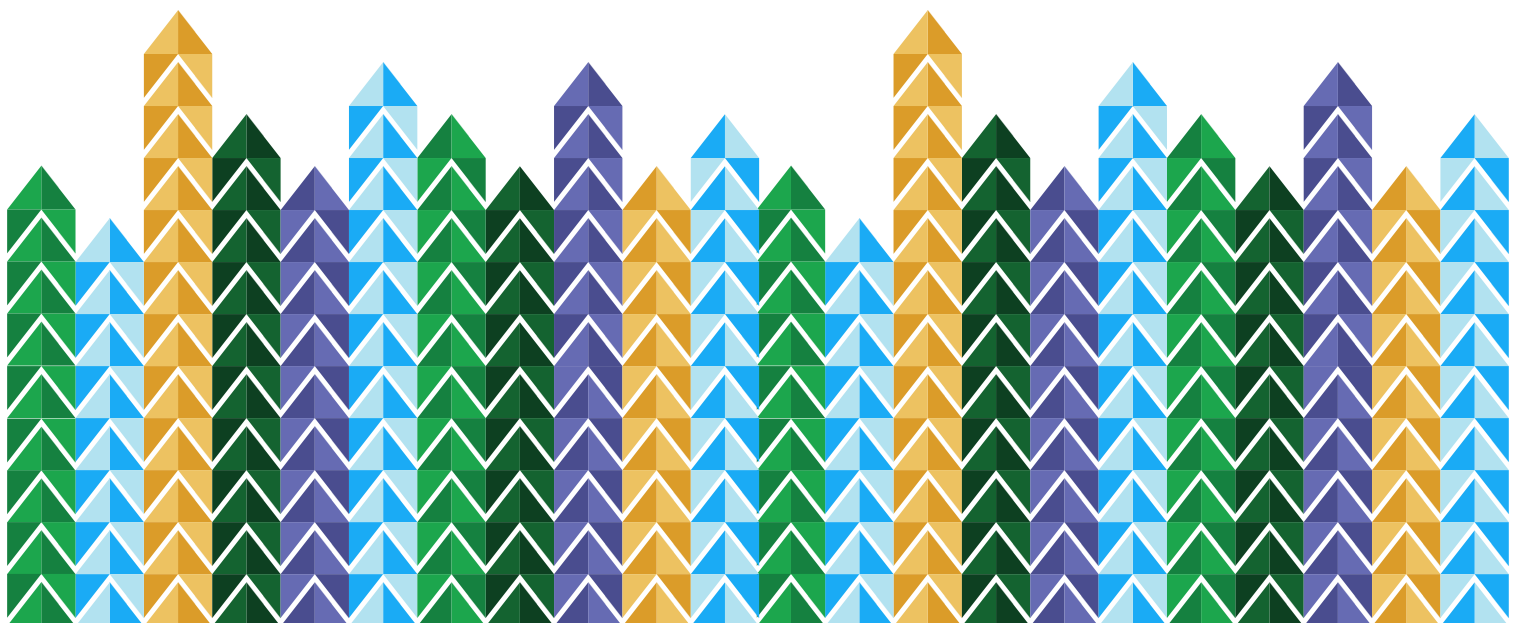
RARE Experiences: Interweaving Study Abroad and Student-Directed Research in a Transdisciplinary Program

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It is almost a truism that high-impact practices (HIPs) have a powerfully positive impact on students. Many studies have shown that engagement in HIPs encourages the development of analytical skills (Álvarez-Huerta, Muela, and Alexander 2023); fosters a sense of identity (Palmer et al. 2015); improves engagement with the campus community (McDaniel and Van Jura 2022; Ndoye 2023); and helps prepare undergraduate students for postgraduate experiences (Richard et al. 2021; Sobeck et al. 2023). But despite their value HIPs are often notably disintegrated, siloed, and separated, forcing students to choose between them due to limitations of time and funding. Not only can this lead to students missing out on valuable experiences, but it also can engender repetition of the process, dilution of resources, and difficulties with support.

Integrating aspects of multiple HIPs under a single programmatic roof is not always the best solution, nor is it the only way to solve these problems. However, integrated programmatic models do offer interesting additions to the HIPs tool kit, along with distinct challenges. The experience of developing and implementing one such program illustrates both the opportunities and obstacles that such a model can provide.

The Radford Away Research Expedition (RARE) program was developed to provide students with an exceptional off-campus experience that was both deeply interdisciplinary and focused on student-directed research. In its initial conception, RARE invited students from every major and department across campus to propose an individual scholarly research project that they could execute during a three-week excursion to a field station in a remote region of the Amazon rainforest. Teams of two faculty, ideally from disparate disciplines, coordinated a semester-long preparatory course and worked with professional guides to ensure that each student could conduct their own project while traveling.

RARE's core value is to engage students in guided but self-directed research, helping each of them practice real-world scholarship in their own academic disciplines. This capstone project–style model is central to the conception of the program; students do not join projects developed by faculty mentors, but rather take the lead in developing their own personalized scholarly exploration with support and guidance from a student-chosen mentor in their discipline. During the preparatory class, the field experience, and succeeding presentations and publications, students are encouraged to view themselves as experts in their field, representatives of their discipline, and explorers in their own right. Inculcating this sense of agency, ownership, and personal drive is foundational and contagious; as in other HIP programs, the modeling of peers amplifies engagement with the program (An and Loes 2023).

In much the same way, the deeply transdisciplinary nature of RARE encourages students to lean into their own scholarly interests and to explore intersections with other fields. When they are not conducting their own scholarship, students are expected to serve as aids to their peers, helping them conduct interviews, collect samples, take photographs, etc., regardless of discipline. These experiences encourage student projects to merge arts, sciences, and social sciences in creative and unique collaborations. This fusion also allows for vibrant, engaging discussions, with dynamic conversations on "big picture" topics being a hallmark of the program.

The study abroad/study away model is also central to the RARE program, not only for the excitement and sense of wonder that off-campus travel can bring, but even more for the "real-world" engagement it enables. Immersion provides the opportunity for students to grapple on a personal level with ongoing issues and pushes them to engage closely with members of the communities they meet, learning directly from them and generating personal connections.

The RARE model has proven to be profoundly successful at engaging students. Ninety-seven students have participated in the RARE program to date. One hundred percent of those have graduated, or are currently on track to graduate within five years. The vast majority have gone on to find success in graduate-level programs (MFA, MS, PhD, DVM, PA, DO, NP, MD, MPH) and the job market. As importantly, alumni have formed a resilient community, maintaining contact with each other and with the program, eager to assist and advise incoming students.

If successful implementation of the model were limited to the Amazon site, RARE's utility would obviously be restricted. In 2023 the RARE model was brought to field experiences based in southwestern Virginia. Students immersed themselves in the mid-Appalachian region, conducting original projects, exploring the landscape, and engaging with local peoples, under the guidance of two faculty mentors. By all available metrics, RARE in Appalachia was as successful as previous iterations in the Amazon, and it is anticipated that both of these trips will run in the future. There is now work to develop a RARE-based program in which students conduct interdisciplinary research in proximity to campus, allowing the program to be conducted during the semester. So long as the program retains the key points of disciplinary integration, student-led scholarship, and "real-world" off-campus engagement, it fits under the RARE umbrella.

There are challenges and difficulties with the RARE model. Finding financial support for such a multidisciplinary program is often difficult; traditional funding sources do not easily incorporate programs that exceed their mandates. Similarly, funding for research with undergraduates, particularly research abroad, has proven difficult to obtain in the abbreviated time scale of project development.

The multidisciplinary nature of the program also poses a challenge for recruitment, of both students and faculty. Finding qualified and willing faculty participants from diverse disciplines and keeping them engaged across multiple years of the program can be tricky. Similarly, students from disciplines that do not traditionally conduct fieldwork or study abroad off-campus, such as nursing, dance, computer science, or business, may be difficult to recruit due simply to their expectations that the program is "not for them." Compensating for these inherent biases requires substantial investment in recruitment.

In sum, integrating student-focused research, on-site engagement, and off-campus study in a program such as RARE can leverage the various strengths of these strategies to amplify one another. Although it is not without hurdles, it is believed that the inherent worth of these types of integrated programs are greater than the sum of their parts, and their development is strongly encouraged.

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Research Ethics: Best Practices for Training Undergraduate Researchers

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During the last five decades, efforts to promote training in research integrity in the United States have seen increased pressure from government agencies, professional societies, institutions of higher education, nonprofits, and industry. The need for this training has its early origins in the recognition of horrific crimes against individuals committed by doctors during the Nazi era, documentation of the effects of thalidomide on fetuses, the Tuskegee study, and recognized abuses in research involving animal subjects. After the publication of the Belmont Report in 1978 and the recognition of other issues associated with research misconduct regarding animals in the early 1980s, the US Congress passed the Health Research Extension Act in 1985. The Secretary of Health and Human Services issued a regulation requiring institutions to establish administrative processes to review reports of scientific fraud and report alleged cases appearing substantial to the secretary. Multiple efforts and reorganizations led to the creation of the Office of Research Integrity, which in 2002 created the Responsible Conduct of Research (RCR) Resource Development Program to facilitate the creation of RCR instructional materials within the research community.

Although the origins and primary focus of research integrity efforts were on biomedical fields (including psychosocial, natural, and physical sciences), the importance of training researchers in all science and nonscience fields on RCR topics to maintain the integrity of the research enterprise has more recently been emphasized. With the advent of artificial intelligence, other fields ranging from the visual and performing arts, linguistics, and history, to the sciences, engineering, medicine, economics, and political science have reemphasized the importance of disseminating codes of research conduct through their professional societies and organizations.

Research misconduct cases are minimal in comparison to the large number of well-carried-out investigations that abide by ethical rules. However, we continue to occasionally see such cases hitting headline news, and, in some cases, making the public believe misconduct is very prevalent or providing distorted views of research outcomes. The cases we encounter more frequently and that do not make the news are about questionable research practices rather than misconduct. As more questionable research practices and results get disputed by peer researchers and the public, the importance of proper RCR training at all levels of the research enterprise has become more relevant than ever.

When thinking about undergraduate researchers, the generalizability of certain topics can make an early introduction to RCR principles very impactful and relevant, even for students planning to change fields in their advanced studies. Therefore, experts agree that the ideal time to begin training individuals in the responsible conduct of research is when they first begin their exposure to the research environment, as undergraduates participating in course-based undergraduate research experiences (CUREs) or being mentored by faculty in independent research projects.

Out of convenience, most institutions have adopted online training for researchers of all levels. Faculty, postdoctoral fellows, graduate, and undergraduate students are expected to complete online modules that best approximate their area of research, and the training must be retaken every year to remain in compliance (e.g., CITI Program). The modules are highly focused on individuals conducting research in the biomedical, physical, and psychosocial sciences, with a strong emphasis on the protection of human subjects, animal subjects, and data protection, although research misconduct, which encompasses cases of falsification, fabrication, and plagiarism, applies to any field. Although practical and valuable, such online training does not provide the long-lasting learning that face-to-face discussions do.

To be inclusive and have an enduring impact, the training of undergraduate students in the responsible conduct of research should also incorporate a combination of information with real reflections and discussions of case studies. Discussion with peers as well as with an expert instructor or facilitator to help clarify concepts, policies, procedures, and the availability of resources help solidify a code of conduct for students. RCR workshop sessions courses are most effective when students:

- are actively encouraged during workshops to look up, define, and report information on general principles of research integrity with an emphasis on the values that all ethical researchers should live by (e.g., honesty, fairness, accuracy, efficiency, objectivity, openness, trustworthiness, respect);
- learn about the most important topics that are generalizable to all research fields: research misconduct (fabrication, falsification, plagiarism, failure to comply with federal regulations), and questionable research practices associated with advising or mentoring; the treatment of data; mistakes and negligence; responding to suspected violations of professional standards; human participation and animal subjects in research; laboratory safety (for fields involving lab work); sharing of research and scholarly work; authorship and the allocation of credit; reproducibility; intellectual property; competing interests; commitments and values; and the researcher in society;
- are exposed to case studies, either from real life or realistically fictitious, and must discuss and respond to questions associated with the topics above;
- are encouraged to role-play during discussions of cases: putting themselves in the shoes of characters in the case study, such as another undergraduate or graduate student, a postdoctoral fellow, a faculty member, or someone from the general public, can elicit a better understanding of the situation being discussed, and if the role being played involves someone from a different racial, ethnic, or socioeconomic background the discussion may be enriched with issues of access, diversity, equity, and inclusion; and
- discuss cases that may not be directly related to their own research field, but that put them or a loved one in a situation of being a subject of the research in question (e.g., a chemistry student seeing a sociocultural study case involving human subjects research in an indigenous community requiring participants like themselves, or a communications student seeing a case of laboratory safety violations potentially endangering the public).

In summary, the earlier undergraduate students involved in research or scholarly or creative activities are exposed to research integrity topics that include discussions with an expert facilitator, the sooner they become responsible practitioners and advocates.

Assessment Practices for Undergraduate Research Experiences

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Thinking about how to assess undergraduate research may not be among the first things one considers when following the *Characteristics of Excellence in Undergradaute Research (COEUR)* best practices. But sooner or later, you might need to convince campus administrators and funders of the benefits of the investments they are making in a campus-wide undergraduate research office with a full- or part-time director, who runs programs providing stipends, supplies, and travel money. Collecting qualitative and quantitative assessment data is one useful strategy for building a case to sustain or grow your undergraduate research office. A resource to consider in this regard is the EvaluateUR method and its variants, developed for use with different types of research experiences. EvaluateUR is well aligned with *COEUR*'s "assessment activities" function and complements several of its other characteristics.

The EvaluateUR method (EvaluateUR Method 2024) is a product of years spent as the founding director of SUNY Buffalo State University's Office of Undergraduate Research, and of involvement with the Council on Undergraduate Research (CUR). Although the university administration was largely unaware of the growing national interest in high-impact practices such as undergraduate research, some of the characteristics listed in *COEUR* were already in place on campus when I (Jill Singer) was appointed director in 2001. Faculty across the campus were engaging their students in research in the arts, natural and applied sciences, humanities, and education. There was adequate space, eager and talented students, and a reward structure that recognized the value of teaching and mentoring students. Armed with knowledge from my supportive and helpful CUR colleagues and a stack of CUR journal articles, I started by introducing three campus-wide programs: a funding program for summer research; a program to cover field, lab, and travel-related research costs; and a conference support program to fund student and mentor travel to present research findings. We also introduced a campus-wide student research conference. Over the next 20 years, both the amount of funding and the number of programs grew and then stabilized. Undergraduate research became institutionalized, and even when fiscal challenges were encountered, the undergraduate research programs were not eliminated. Reflecting on why support for undergraduate research has persisted on my campus, my early interest in gathering meaningful assessment data tops the list.

Once the office's programs were up and running, I recognized the need to provide more than just participation metrics in my annual reports. I looked once again to CUR for advice, and although there was assistance, most of the evaluation surveys that CUR members shared with me, workable for STEM disciplines, were not well-suited to assessing research activities in the varied non-STEM fields that our Buffalo State programs supported. The available surveys also relied heavily on student perceptions about the benefits to them of conducting research, and although perceptions are important it has been shown that such data can be inaccurate. I partnered with Dan Weiler, and together we developed an assessment strategy that would integrate directly with the research experience, help students accurately self-assess their strengths and weaknesses, and provide reliable data that undergraduate research program directors could use to document the impacts and benefits of undergraduate research. The design has features to mitigate some of the limitations of relying on perceptions, including: (a) repeated assessments (at the beginning, middle, and end of the research experience); (b) assessments in which students and mentors use the same outcome categories and components; and (c) a scoring rubric that defines the meaning of each assessment score. Each assessment is followed by a student-mentor or student-adviser conversation to compare and discuss the reasons behind the respective assessments. In the EvaluateUR method, we emphasize that these conversations are more important than the scores and are intended to provide students with new insights into their thinking processes and learning strategies.

After testing and refining this model for several years at Buffalo State, I obtained funding from the National Science Foundation in partnership with Sean Fox at the Science Education Resource Center (SERC) to develop an online implementation of this method that is easily accessible and applicable to other campuses (Grinberg and Singer 2021; Singer and Weiler 2009; Singer et al. 2023; Singer et al. 2022; Singer and Zimmerman 2012). This support system, known as EvaluateUR, automates the prompting and collection of assessment data from students and mentors over the course of the research, provides tracking of progress, and gives program administrators the resulting data in both convenient summaries and spreadsheet format.

Since its initial introduction, and with additional funding from the National Science Foundation, we have developed several other variants of EvaluateUR to support: (a) course-based undergraduate research experiences (EvaluateUR-CURE); (b) collegiate engineering competitions (Evaluate-Compete); and (c) internships (EvaluateUR-Internship). Each of these variants includes one or more options that increase their flexibility. All of the EvaluateUR method variants share common characteristics and features (Table 1) and the EvaluateUR website includes resources to orient new users ("Onboarding for E-CURE Instructors" 2024).

TABLE 1. Key Features of the EvaluateUR Method

Students are assessed in diverse range of outcome categories, with each category defined by several components that include both content knowledge and outcomes important in the workplace.
Option to add additional outcomes that reflect specific program-wide objectives.
Before the research/project begins, students answer open-ended questions to share their thoughts about the research process.
To assess student progress, selected outcome components are self-scored by the student using a five-point scale and accompanying scoring rubric.
Conversations are conducted after assessments, providing the opportunity for students and mentors, advisers, or internship supervisors to consider progress and help students understand their strengths and weaknesses as they work to achieve these outcomes and develop or enhance related metacognitive skills.
Summary statistics are automatically generated, with an online guide explaining ways to use generated data.

The EvaluateUR method supports all academic disciplines, and the comprehensive set of outcomes ("Outcomes" 2024) has been successfully implemented across STEM, as well as in the arts and humanities (Kinkead, Draeger, and Singer 2023; Singer and Weiler 2009). The outcomes align well with those of other work (Hunter et al. 2007; Lopatto 2004; Seymour et al. 2004) and map to the National Association of Colleges and Employers (NACE) career readiness competencies (NACE Center n.d.) and ABET student learning outcomes (Grinberg and Singer 2021). The method is appropriate for all levels of research courses and experiences. Resources are available on the EvaluateUR method site to orient new users to the method, including step-by-step instructions for setting up dashboards, accessing and downloading data, and guides that explain how to use the data. Because metacognition is integral to the EvaluateUR method, a set of short, nongraded metacognition exercises ("Metacognition" 2024) are available, as is a metacognition card game.

Finally, for new directors of undergraduate research programs, adopting the EvaluateUR method removes the need to create your own assessment surveys. All of the variants have undergone pilot testing to establish their validity, so you can have confidence in the reliability of the data ("Why the EvaluateUR Method Is Effective" 2024). The built-in data features reduce the need to hire a professional evaluator to create your campus or program surveys, and save both time and money. Engaging with a colleague who can assist in interpreting the data collected can be very helpful in pinpointing areas of excellence and areas in which adjustments to the program or research course may be needed. And, although obtaining meaningful data is certainly one of the reasons to consider using the EvaluateUR method, it is first and foremost a learning tool grounded in helping students enhance their metacognitive skills.

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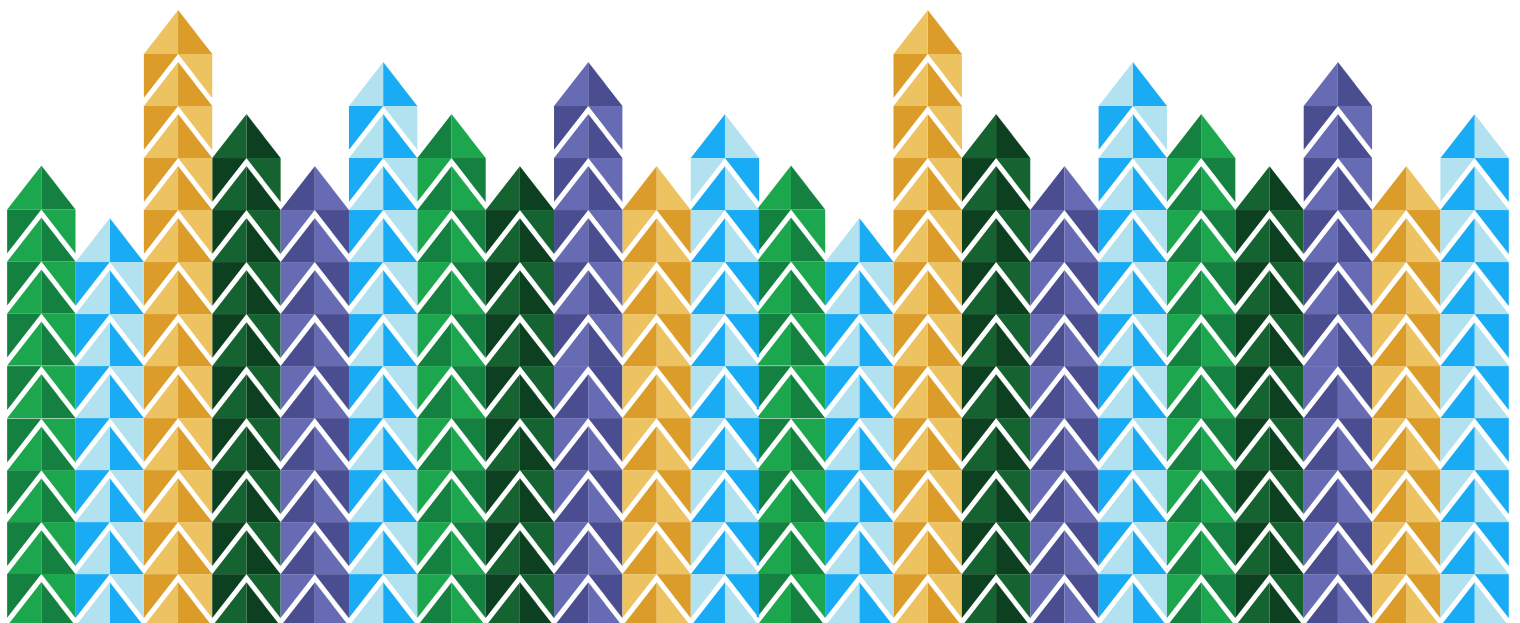
Case Studies: How Institutions Have Incorporated *COEUR*

Undergraduate Research Opportunities Center
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Centrally located in the Tanimura and Antle Family Memorial Library, the Undergraduate Research Opportunities Center (UROC) at California State University Monterey Bay (CSUMB), a designated Hispanic-serving institution (HSI), is a cross-campus center that trains, supports, and engages students in undergraduate research. UROC participants work on relevant and innovative research and scholarly activity at CSU Monterey Bay and at regional, national, and international research institutions, guided by research mentors on campus and frequently at other institutions. Through its signature UROC Scholars (including Ronald E. McNair Scholars), Koret Scholars, Apple Scholars, the Louis Stokes Alliance for Minority Participation (LSAMP), UROC Researchers, and Research Rookies, UROC supports students with wraparound scaffolded services that include extensive training in research proposal writing, presentation skills, communication skills, professionalism, and graduate school preparedness. In addition to offering robust undergraduate research opportunities, UROC administers several national research scholarships and fellowships that offer advisory support to applicants (e.g., Goldwater, Udall, Fulbright US student programs) as well as CSU-specific statewide scholarships (i.e., California Pre-Doctoral Program).

UROC Fast Facts
- UROC has provided over 1000 funded undergraduate research opportunities for CSUMB students since its inception.
- Over 1000 participants have taken part in UROC professional development programs.
- Over 850 participants have disseminated their research at UROC symposia; over 550 students have presented at national conferences.
- Eighty-two percent of UROC participants have been from traditionally underrepresented groups, including: 42 percent traditionally underrepresented minorities; 45 percent first generation at undergraduate institution; 44 percent Pell Grant recipients; 41 percent transfer students.
- Over 900 CSUMB students a year participate in course-based undergraduate research experiences (CUREs) developed through the CURE Fellows program.
- Over 65 students have won prestigious national scholarships and fellowships since 2015.

Students have multiple opportunities to present and publish their findings. Throughout the year, in collaboration with the library, UROC hosts four campus-wide events seasonally: the CSUMB Summer Research Symposium; the Fall Undergraduate Research, Scholarship, and Creative Activity Competition; the Spring CSUMB Undergraduate Research, Scholarship, and Creative Activity Showcase; and the celebration of National Undergraduate Research Week. These events are a forum for both graduate and undergraduate students from across 12 different academic disciplines to share their research, scholarship, and creative works through oral and poster presentations within CSUMB and the surrounding community. These presentation opportunities offer undergraduates an opportunity to supplement discipline-specific knowledge connected to course content as well as acquire a sense of belonging within their respective research communities, and they are well-positioned to present research nationally at discipline-specific conferences and compete statewide at the CSU Student Research Competition. To prepare students for these research dissemination events, UROC offers support through workshops facilitated by UROC staff (i.e., how to write an abstract, how to create a research poster or oral presentation, and what to expect at a research conference); poster printing and mounting; and, pending funding, expenses for conference presentations. Faculty mentoring of students in research and scholarly activities is recognized annually by a Mentor of the Year award presented at the UROC Year-End Celebration.

UROC activities are largely supported by external grant funding procured by UROC staff, including capacity-building grants from the Department of Education (HSI-STEM, McNair) and the National Science Foundation (CSU-LSAMP), as well as community and corporate donor contributions (e.g., Koret Foundation, Apple, Chevron). Total external support garnered by UROC since the program's inception in 2009 is well over 13 million dollars. Funds go to support student research scholarships, conference attendance, research supplies, and hospitality for events and workshops. Furthermore, faculty seek external funding for their research, often integrating undergraduate research engagement into their grant activities, providing even more research opportunities. Global learning opportunities (including an annual Costa Rica research immersion program, geared toward undergraduates from across CSU campuses, developed by UROC and supported by CSU-LSAMP) afford students a chance to combine or "stack" high-impact practices. Taken together, these experiences prepare CSUMB students for successful academic or professional careers.

Full-time staff supported by campus academic funding include a director and staff members responsible for developing and teaching UROC seminars; research placements; writing instruction; national scholarship and fellowship advising; peer training (i.e., UROC Peer Writing Fellows and UROC Ambassadors); outreach; and evaluation and assessment of high-impact practices. Staff work in a designated space located in the campus library, which includes offices and conference rooms where students, staff, and faculty can congregate. Nearby units include the Office of Inclusive Excellence and Sustainability, First-Year Seminar, and the Cooperative Learning Center (tutoring), providing excellent opportunities for staff to intersect and collaborate with critical student units. Purposeful collaboration and coordination with different campus support programs such as a centralized Ronald E. McNair Advisory Collective—a group of faculty, staff, and administrators who are Ronald E. McNair alumni—help support staff meet program outcomes and goals and interact with first-generation, underrepresented students to support their goal of bridging to doctoral programs.

Ongoing evaluation and assessment of active-engagement learning interventions across campus represent one of the core initiatives at UROC. This is facilitated by strong ties to the Council on Undergraduate Research (CUR) (including involvement in research design and implementation of national surveys and discussions, along with campus support for an Enhanced Institutional CUR membership) and includes maintenance and advertising of the Enhanced Institutional CUR membership on campus. Widespread dissemination of UROC staff research and scholarship and robust engagement in national discussions on student learning, diversity, equity and inclusion, and undergraduate research support the mission of UROC to engage students of all majors in undergraduate research and build students' educational ownership, intellectual vibrancy, and scholarly identity.

Curricular innovations (hands-on engagement in signature programs, procuring equipment to support research in science, arts, etc.) are a hallmark of support for faculty research. Furthermore, UROC engages with faculty on campus coordination of CUREs, including CURE retreats and professional

development support for faculty across disciplines to revise and develop new curricula that integrate authentic research engagement into the classroom. Over 900 CSUMB students a year participate in CUREs, and 93 percent of students report being more motivated to go to graduate school after participating in research, supporting the UROC mission to engage students in research at the highest levels as a high-impact practice.

The Summer Institute in the Arts and Humanities
Sophie Pierszalowski
University of Washington

The Summer Institute in the Arts and Humanities (SIAH) was created in 2001 by the Office of Undergraduate Research (formerly known as the Undergraduate Research Program) and the Walter Chapin Simpson Center for the Humanities, with sponsorship from the Office of Research and the Mary Gates Endowment for Students. SIAH is a course-based, immersive summer research opportunity offered at the University of Washington (UW) with the primary purpose of expanding the number of paid opportunities for undergraduates to engage in meaningful arts and humanities research experiences. It accomplishes that mission in two ways: (a) by providing arts and humanities research experiences for selected students; and (b) by inspiring SIAH faculty to expand their practice of engaging undergraduates in research following their SIAH experience.

Program Partners
The UW Office of Undergraduate Research and the Walter Chapin Simpson Center for the Arts and Humanities share responsibility for facilitating SIAH. Primary responsibilities of the Simpson Center include identifying and supporting the instructional team (e.g., by connecting them with previous instructors for guidance), and submitting the course to the schedule of summer classes. Primary responsibilities of the Office of Undergraduate Research include managing student applications (e.g., marketing and hosting informational sessions); facilitating the award process (e.g., sending acceptance materials and disbursing student payments); hosting a welcome luncheon; supporting logistics for a final showcase; and conducting student and faculty assessment. Both units collaborate on budgeting and preparing summer appointment letters for the instructional team.

Program Expenses and Sponsors
The Mary Gates Endowment for Students provides funding for student scholarships, and students are named Mary Gates Research Scholars for their involvement. Approximately one month of salary for three faculty and one graduate student is funded by revenue from summer quarter tuition with support from the Office of Research and the Simpson Center. The Simpson Center also provides a research and planning stipend for faculty instructors in the spring quarter preceding the program. Additional funding from the Office of Research facilitates program events and field trips, invitations to guest speakers, and the hosting of a final research showcase or exhibit.

Program Structure
Instructional Team and SIAH Theme: Each year, the Simpson Center assembles an instructional team consisting of three faculty members and one graduate student who are available to facilitate SIAH over the summer and can coalesce around a common theme. Examples of recent SIAH themes include "A Black Sense: Time, Art, and Being"; "Monumental Reckoning: Unsettling Histories, Reimagining Futures"; and "Contested Bodies: Power, Identity, and the Life Cycle." Each theme is interdisciplinary and draws on the expertise and interest of the instructional team members, who come from diverse disciplinary spaces. The instructional team selects the final cohort of 20 students, designs and teaches the summer curriculum, and guides each student through the completion of an independent research project connected to the theme.

Student Experience: Students formally apply to the program in the winter, and top candidates are selected for interviews in the spring. Selected students enroll in 12 upper-division humanities credits over the summer. These credits satisfy their writing requirement for graduation. The course is facilitated by the instructional team and involves guest lectures, field trips, small group work, and individual reflection. In the first half of summer, students are exposed to new ideas, theories, and readings, which are intended to inspire ideas for students' independent projects. In the second half of the summer, students delve deeper into a specific area of focus and develop individual research projects.

Dissemination: SIAH's interdisciplinary theme forms the basis of the student's individual research projects. Students present their projects in a final showcase or exhibit at the end of the summer. Students have produced high-quality projects that they have subsequently been presented at art galleries, film festivals, theaters, and scholarly conferences, as well as in professional publications. Students are invited to present at UW's Undergraduate Research Symposium in the spring of the following year, which includes a Visual Arts and Design Showcase and a Performing Arts Showcase. SIAH students are also encouraged to apply for a Conference Travel Award, facilitated by the Office of Undergraduate Research, if they are accepted to present at a professional research conference.

Opportunities for Early and Sustained Involvement
Scott Cooper and Nicholas Bakken
University of Wisconsin–La Crosse

The academic and developmental benefits of getting involved in undergraduate research early in a student's academic career have long been recognized. At the University of Wisconsin-La Crosse (UWL), the campus mission and culture dictate providing students with experiential learning opportunities both inside and outside the classroom. Engaging students in high-impact practices and experiential learning early in their undergraduate career increases retention and overall success.

UWL has encountered challenges in engaging first-year students in undergraduate research and creative projects, including obtaining funding, recruiting and retaining students, and finding mentors for students. Maximizing collaborative financing models has been one way to accomplish funding for undergraduate research.

The best example of collaborative financing is the Eagle apprenticeship program. This initiative began in 2013 as a four-student pilot project led by the Office of Admissions, the Office of Financial Aid, and the Office of Undergraduate Research and Creativity. Each year, the admissions office identifies 25 to 35 high-achieving students they want to recruit to the university. The Eagle Apprentice program is funded through an institutional resource designated for student financial aid and scholarships. These funds are merit-based and used to recruit and retain high-achieving high school students. Eagle Apprentices receive a $1,000 scholarship in their first and second years, and the Office of Undergraduate Research and Creativity asks students about their degree and career plans and matches the incoming first-year students with faculty mentors in their areas of interest.

In this way, all three collaborating offices benefit by meeting their programmatic goals. The admissions office can recruit high-achieving students by offering more than just the $1,000 research scholarship; the students also benefit from research experience and a long-term relationship with a faculty mentor. The Office of Financial Aid knows that the funds they are awarding students are getting a value-added boost by providing these students a valuable research experience with a faculty mentor. The Office of Undergraduate Research and Creativity benefits by supporting an additional 50 to 60 students in research projects at a formative time in their education. Overall, the Eagle apprenticeship program has been advantageous for participating faculty mentors, the student apprentices, and all three supporting offices.

From a practical standpoint, the Office of Admissions decides which students to recruit with an Eagle apprenticeship. The major factors have been ACT scores, high school percentile, and grade point average (GPA); they also take into account intended major and diversity. The 194 Eagle Apprentices from 2014 to 2019 were, on average, in the top 2 percent of their high school class with a mean ACT score of 32, compared to the top 22 percent of their high school class and a mean ACT score of 25 for others in the cohort. In correspondence with new Eagle Apprentices regarding their area of interest, many volunteer that one of the main reasons they chose UWL over other campuses was the Eagle apprenticeship program.
As high-achieving students, Eagle Apprentices are likely to have high retention rates even without participating in the program. When comparing first-year Eagle Apprentices to other matched high-achieving students, there is a slightly higher second-year retention rate for Eagle Apprentices (97 percent compared to 90 percent) and a positive effect on UWL cumulative GPA (mean

of 3.77 vs. 3.48) and earned credit levels at the end of the first year (31.6 vs. 29.8). Eagle Apprentices also had a six-year graduation rate of 89.7 percent, greater than the 71 percent average for the entire student body.

In addition to increasing the recruitment and retention of students, a long-term goal is to encourage these students to remain involved in undergraduate research. Eagle Apprentices were far more likely than their peers to write grants and present at a conference. Of the 129 Eagle Apprentices, 68 have had at least one further research experience, suggesting that this program promotes long-term involvement in undergraduate research.

In sum, the Eagle apprenticeship program serves as a pipeline to direct students to future undergraduate research opportunities. Students benefit financially, from increased training in their major, and by forming strong ties with a faculty mentor. Some students also learn in their first year or two that they want to switch majors and can do so without an undue delay in graduation. Faculty mentors often retain highly trained students to work on projects with them as the students become third- and fourth-year students, and the campus benefits by recruiting and retaining high-achieving students. Nationally, as the pool of graduating high school students shrinks over the next decade, this program can be adopted by other campuses to recruit and retain high-achieving students and to increase student involvement in undergraduate research and creativity.

Research that Reaches Out
Kathryn D. Kloepper
Mercer University

Mercer University supports a robust undergraduate research program that spans the disciplines, ensuring that "at Mercer, every student majors in changing the world." Significant investments in curricular programs, research facilities, and conference travel promote broad participation in on-campus research and creative activities, student presentations at external conferences, and undergraduate coauthorship. These research accomplishments are celebrated frequently and broadly. The university's emphasis on service-focused research is embedded in the mission statement, "to teach, to learn, to create, to discover, to inspire, to empower, and to serve."
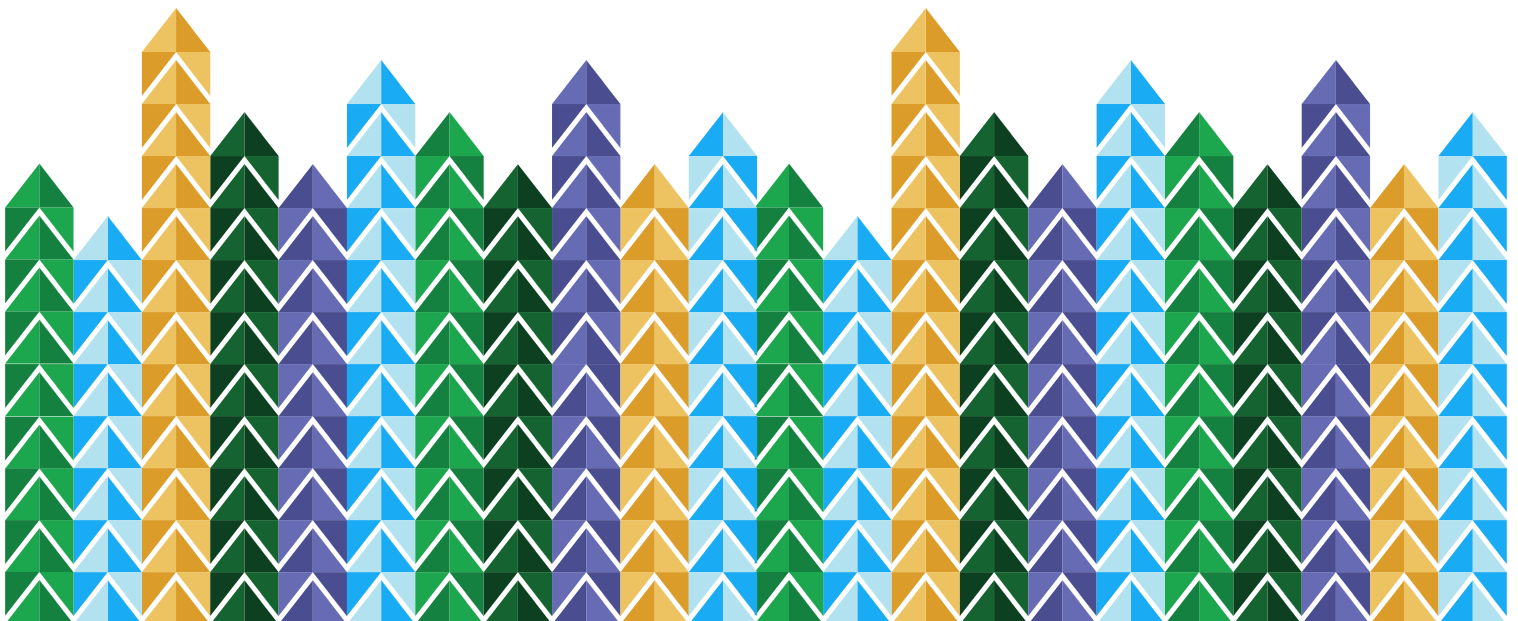
Mercer is committed to recruiting and supporting faculty who want to participate in significant research and creative activities with students. During the hiring process, faculty candidates are asked about their plans to work with undergraduate researchers. Mercer faculty commit to excellence in teaching and peer-recognized scholarship. Faculty are required to disseminate their scholarship through conference presentations and discipline-appropriate peer-reviewed products. The inclusion of undergraduates in this work is celebrated. Each spring, undergraduate classes are canceled for one day

to allow for a full-day celebration of undergraduate research and creative activities called BEAR Day. Furthermore, Mercer's marketing communications team frequently profiles student-faculty research accomplishments in internal and external communications, and the mentorship of undergraduate researchers is encouraged and recognized as part of annual reviews and the tenure and promotion process.

This culture of service-based research was strengthened with the 2015 implementation of Research That Reaches Out, a curricular program that integrates two high-impact practices: undergraduate research and service learning. When participating in Research That Reaches Out, undergraduates receive early and sustained involvement in service-based research. The scaffolded curriculum provides students with the experiences and skills to engage in sophisticated research aimed at addressing real-world problems. Mercer's 10-year strategic plan, Inspire: Mercer's Vision for the Decade Ahead, includes clear goals for supporting undergraduate research, including a continued emphasis on the Research That Reaches Out service-research program.

Lessons learned from many years of implementation and evaluation of Research That Reaches Out are transferrable to other institutions. Others seeking to implement service-research are encouraged to find existing places in the curriculum where a first exposure to service-research can be incorporated. Augmenting existing courses—particularly those in general education sequences—allows for low-resource investments of time and money while maximizing student access. Giving students early access to service-research enables them to seek out more opportunities as they progress through the curriculum, strengthens applications for national fellowships, and refines career goals.

Having program support from administration and early adopter faculty and staff is key to widespread implementation and change. When success stories are shared, care should be taken to represent discipline and scope. When funds are available to support course development or project implementation, a demonstrated post-funding sustainability plan can promote greater returns on investments. In many cases, time is a crucial factor for the implementation of new ideas, so the availability of adaptable course assignments, syllabi, and even readings can help lower the activation energy necessary for the design or redesign of courses to incorporate service-research.

Student Voices

Ruby Barone
University of Washington

My immersion in undergraduate research, particularly through the University of Washington's (UW) Summer Institute in the Arts and Humanities (SIAH), stands as a pivotal chapter in my academic journey. Delving into a research project addressing the exclusion of artists of color from traditional art historical and institutional narratives, I spotlighted the work of the lesser-known Black graffiti artist Rammellzee. His artistic endeavors served as a medium for advocating the liberation of minoritized groups from the constraints of language and the Western alphabet.

Navigating this exploration through multiple research symposia at UW allowed me to broaden the reach of Rammellzee's philosophy and contribute to a more inclusive understanding of artistic expression and diverse perspectives. This experience resonated profoundly with me, especially within the context of UWs predominant emphasis on STEM research.

By championing arts and humanities research, I advocated for the importance of diverse narratives within academic exploration. The recognition of my work by the UW's vice provost of research underscored the impact that research focusing on diversity and liberation can have on institutional priorities. In subsequent student-led panels and Q&A sessions, I intentionally furthered my advocacy for research in the arts and humanities, aligning it with my passion for promoting underrepresented voices in academic discourse.

My involvement in SIAH not only inspired my ongoing commitment to promoting diversity and equity in undergraduate research, but also positioned me to engage with similar initiatives in my career. I am proud to now work for UW's Office of Undergraduate Research, where I can continue to fight for accessibility, interdisciplinarity, and inclusivity in undergraduate research across all disciplines. This journey highlights the transformative potential of research in amplifying marginalized voices and fostering a culture of inclusivity in academic institutions.

Lauren Broman
University of Wisconsin–La Crosse

I have always been a curious person. A serial "Well, why?" questioner who was often met with a lackluster "I don't know" response while growing up. My curiosity only grew in high school after taking introductory science classes, so I knew I wanted to get involved with research during my freshman year of college. The Eagle apprenticeship program at the Univesity of Wisconsin-La Crosse allowed me to do just that. The program pairs 25 incoming freshmen with a faculty mentor to conduct research relating to the student's major. I was paired with Dr. Sumei Liu, a professor in the biology department, and began my research experience within three weeks of starting my freshman year. Dr. Liu's research lab focuses on the effects of stress on the intestinal epithelial barrier's function.

During my first two years of research, we investigated how corticotrophin-releasing factor receptor antagonists affected stress-induced increases in intestinal permeability. This year, we examined the role biological sex plays in increased intestinal permeability in irritable bowel syndrome (IBS) patients. Each project involved working with IBS animal models and collecting fluid samples from a Ussing chamber for 9 and 16 days, respectively. We spent the following four months running flux assays to measure intestinal permeability, analyzing the results, and preparing to present at local and national research conferences. Participating in every stage of a research project, from brainstorming to presenting the results, has been one of the most rewarding parts of my college experience.

On a personal level, becoming involved in research has given me a sense of community on campus. I grew up in a small, rural town in Wisconsin where my graduation class was almost identical to my kindergarten class, and a familiar face was never hard to find in public, so attending college in a new town across the state was a daunting thought. Participating in research has created that same small-town feel on campus through bonding with my research partners, building relationships with professors, and introducing me to like-minded, research-oriented students locally and nationally. I know my younger self would be proud to see I am still embracing my curiosity to better myself and prepare for my future through undergraduate research. Thank you to Dr. Scott Cooper and Dr. Nick Bakken for coordinating the Eagle apprenticeship program.

Bianca Cerda
Citrus College

What a journey it has been. As a first-generation college student, I was hesitant about how to navigate my college career. However, it started with my interest in science and research. I joined every STEM-related program on campus. I met so many inspiring students and professors, which was encouraging and reassured me that one day, I could end up with a successful story of my own. Of course, being a full-time student and mom of two was challenging, but for that very reason, I knew I had to take every opportunity to succeed. My summer research experience at the Oak Crest Institute of Science is where it all began.

I was filled with nervousness and excitement when I got accepted. On the first day of my research experience, I was greeted by Dr. Paul Webster. At the time, I did not know how much of an impact he would have on my journey to becoming a scientist. I went in knowing minimal lab skills. However, throughout my time at Oak Crest, I developed various lab skills and learned how to operate different lab equipment. Dr. Webster gave me all the tools needed to succeed, but it was up to me to make every decision in all my lab experiments and studies. Our team decided to study biofilms during our summer research experience. During my summer research, I also gained knowledge in cellular biology, microbiology, electron microscopy, and immunocytochemistry through various experiments I performed in the lab. As the summer research experience came to an end, I received an offer to become a student employee of Oak Crest Institute of Science to continue my training as a scientist. It has been an amazing journey.

Diana Fontes
University of Texas at El Paso

During my undergraduate years at the University of Texas at El Paso, I had the opportunity to delve into the world of research through an internship with Sandia National Laboratories. Reflecting on this experience, I am impressed by the significant amount of knowledge and number of skills I acquired during my tenure as an undergraduate summer intern at Sandia.

It all began with the application process, when I eagerly sought out different additive manufacturing and material science positions through the Sandia website. After applying, I was contacted a few weeks later to proceed with the interview process. This initial interaction sparked a feeling of enthusiasm and anticipation for what was to come.

As the research unfolded, I found myself in a unique situation: working remotely from El Paso for the Sandia site in Albuquerque, New Mexico. Despite the physical distance, my mentor ensured that I felt fully integrated into the team. His commitment to fostering a positive work environment and maintaining open lines of communication made the remote experience seamless and enjoyable. Furthermore, under the guidance of my mentor and within the research and development group, I had the privilege of deepening my understanding of the material science industry. Each day presented new opportunities to expand my knowledge and hone my professional skills. Collaborating with different engineers within the industry allowed me not only to learn from their expertise but also sharpened my communication abilities—a vital asset in any professional setting.

Reflecting on my journey, if I were to offer advice to fellow students aspiring to secure an internship experience, I would emphasize the importance of networking. Attending professional conferences serves as a gateway to building meaningful connections within the industry. By actively engaging with professionals and exploring diverse opportunities, students can kick-start their journey toward securing valuable internships. These interactions not only offer insights into potential career paths but also provide a platform to showcase one's skills and aspirations.

In conclusion, my undergraduate research experience at Sandia National Laboratories was a transformative phase that equipped me with the technical expertise and professional acumen essential for success, specifically in the material science industry. Through remote collaboration, supportive mentorship, and immersive learning opportunities, I gained invaluable insights that continue to shape my academic and career trajectory. As I embark on the next phase of my journey, I am grateful for the experiences and lessons garnered during my time as an intern, which have undoubtedly prepared me for future challenges and endeavors.

Alexander Gomez
California State Polytechnic University, Pomona

My name is Alexander Gomez and I am a food science and technology major at Cal Poly Pomona. I had the pleasure of being a part of several undergraduate research opportunities. I first learned about undergraduate research opportunities through the STEM TRiO program at Citrus College, which offered support and resources to undergraduates in STEM majors. One opportunity that was offered was the Pathways to STEM program, in which undergraduates at Citrus College majoring in STEM, had the opportunity to conduct research in several STEM-based disciplines. This opportunity had a large impact because it allowed me to diversify my skills and try out new fields about which I did not have much knowledge. This opportunity helped me improve my overall skills as an undergraduate researcher and also helped me improve my soft skills in a professional environment.

The Pathways to STEM program led to becoming a part-time employed student researcher at Oak Crest Institute of Science (OCIS) in Monrovia, California, where I am applying the skills and techniques I gained from all my past undergraduate research opportunities to work on several research projects. At OCIS, I have also been able to act as a student mentor whenever we welcome future undergraduate research or high school students into our laboratory by teaching them basic microbiological techniques as well as lab etiquette. To summarize, my undergraduate research journey has been very impactful and beneficial to my future as a student in higher education and has motivated me to achieve more. Previously, I only wanted to pursue a bachelor's degree in my field. Now, because of undergraduate research, I plan to pursue a PhD.

Nicolas Herrera
University of Texas at El Paso

I crossed paths with the Cummins recruiters at the University of Texas at El Paso's (UTEP) 2020 fall career fair. Although the initial attempt wasn't successful, it proved to be an invaluable learning experience, providing insights into the intricacies of interviews. Undeterred, I returned during my sophomore year, navigating through three rounds of interviews that resulted in my offer letter for the summer of 2022. This marked the inception of my journey with Cummins, which extended into the subsequent summer of 2023.

My internship unfolded in Columbus, Indiana, almost an hour from Indianapolis. Working primarily in the engine plant, I was immersed in the pulse of the industry, gaining firsthand exposure to its dynamic nature. The experience highlighted the rapid pace at which operations unfolded and the meticulous structure essential for steering a six-billion-dollar enterprise. Beyond the professional landscape, the internship allowed me to delve into the charm of a small town and savor the distinct flavor of the Midwest.

The guidance provided by my mentors at Cummins played a pivotal role in my internship experience. Their approach was not only supportive but also encouraged independence and critical thinking. Regular weekly meetings and open communication channels created an environment where I felt valued and motivated to contribute my best to the projects. The mentor-student relationship was characterized by mutual respect and a shared commitment to pursuing knowledge.

Beyond acquiring technical skills pertinent to the industry, I underwent a transformative journey of self-sufficiency, learning to navigate the challenges of independent living. Immersing in a professional work environment served as a crucible, refining my communication, problem-solving, and time-management skills—proficiencies that transcend specific industries and find applicability in diverse career paths. Moreover, the experience acted as a gateway to networking opportunities, unlocking doors to potential job offers and signifying a noteworthy shift from academia to the dynamic realm of industry.

For mentors, fostering a supportive and inclusive environment while providing clear expectations can significantly enhance the learning experience. Encouraging open communication and creating opportunities for professional development can further contribute to the success of the mentor-student relationship. For students seeking a similar experience, actively seek opportunities aligned with your interests and career goals. Embrace challenges, maintain open communication with mentors, and leverage the expertise to build technical skills and understand your strengths and areas for growth.

Mathew Luna
Citrus College

My name is Matthew Luna, and I am currently a student researcher at the NASA Jet Propulsion Laboratory (JPL) in Pasadena, California. I became interested in undergraduate research when I began attending Citrus College as a first-year undergraduate. Through one of my peers, I heard about the Pathways to STEM program run by Dr. Marianne Smith, with whom I obtained an interview. I was subsequently admitted into the program, during which I participated in various experiential learning modules that consisted of differing research areas in science. These were composed of microbiology, marine biology, and environmental science modules. During the marine biology experience, I met my current principal investigator, Dr. Laurie Barge, who extended an offer for me to intern at her lab at JPL, where I am now performing Mars-relevant prebiotic chemical research. During the summer of 2023, I also applied to and was selected to participate in the USC Wrigley Scientific Diving Discovery Program (SDDP), where I obtained an AAUS Scientific Diving certification, NAUI Advanced Open Water certification, and Diving First Aid for Professionals certification.

I credit a lot of my interest in undergraduate research to the accessibility of the Pathways to STEM program, as the experience was open for college students to participate in alongside their coursework, and the program coordinators made sure that the many aspects of each experience were equally accessible to low-income students like myself. The USC Wrigley SDDP also furthered my interest in undergraduate research, as it focused on equity and inclusion to bring underrepresented communities into the field of scientific diving. These programs ignited my passion to participate in undergraduate research during my journey, and I am currently pursuing more such programs during the 2024 year, including a possible scientific diving summer research experience.
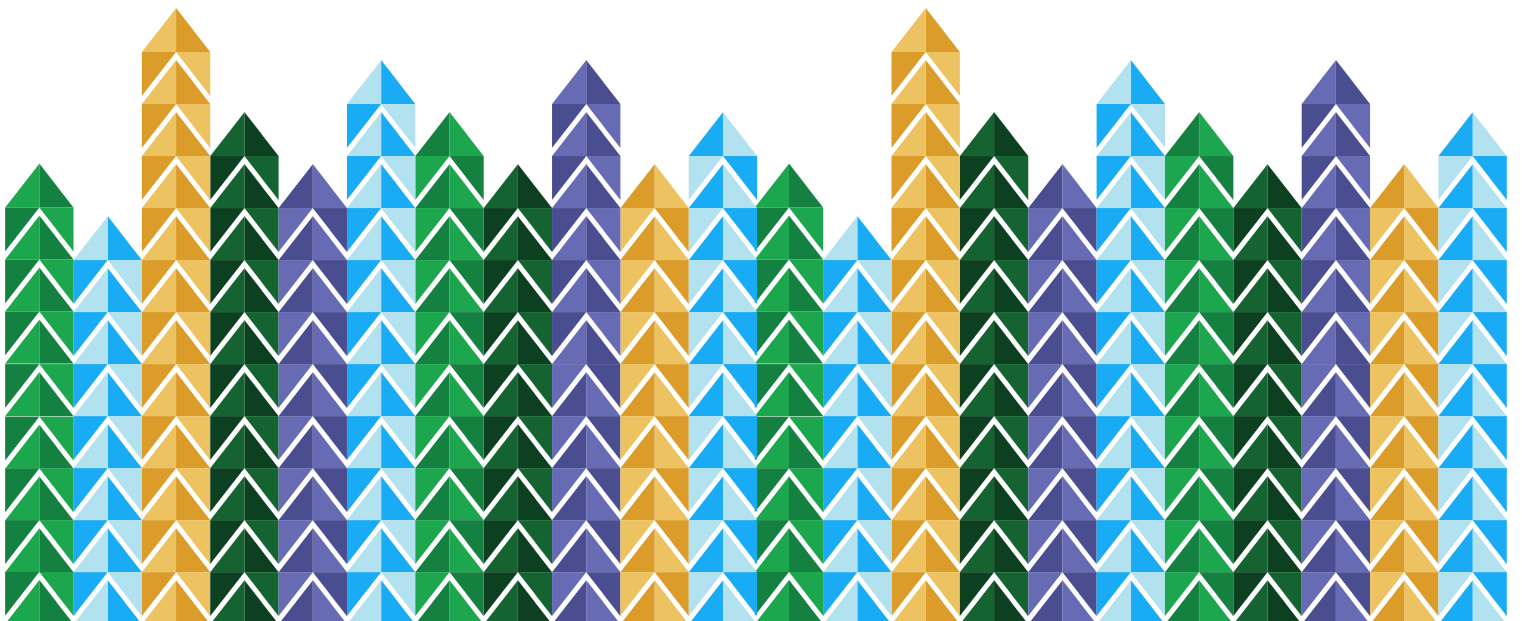
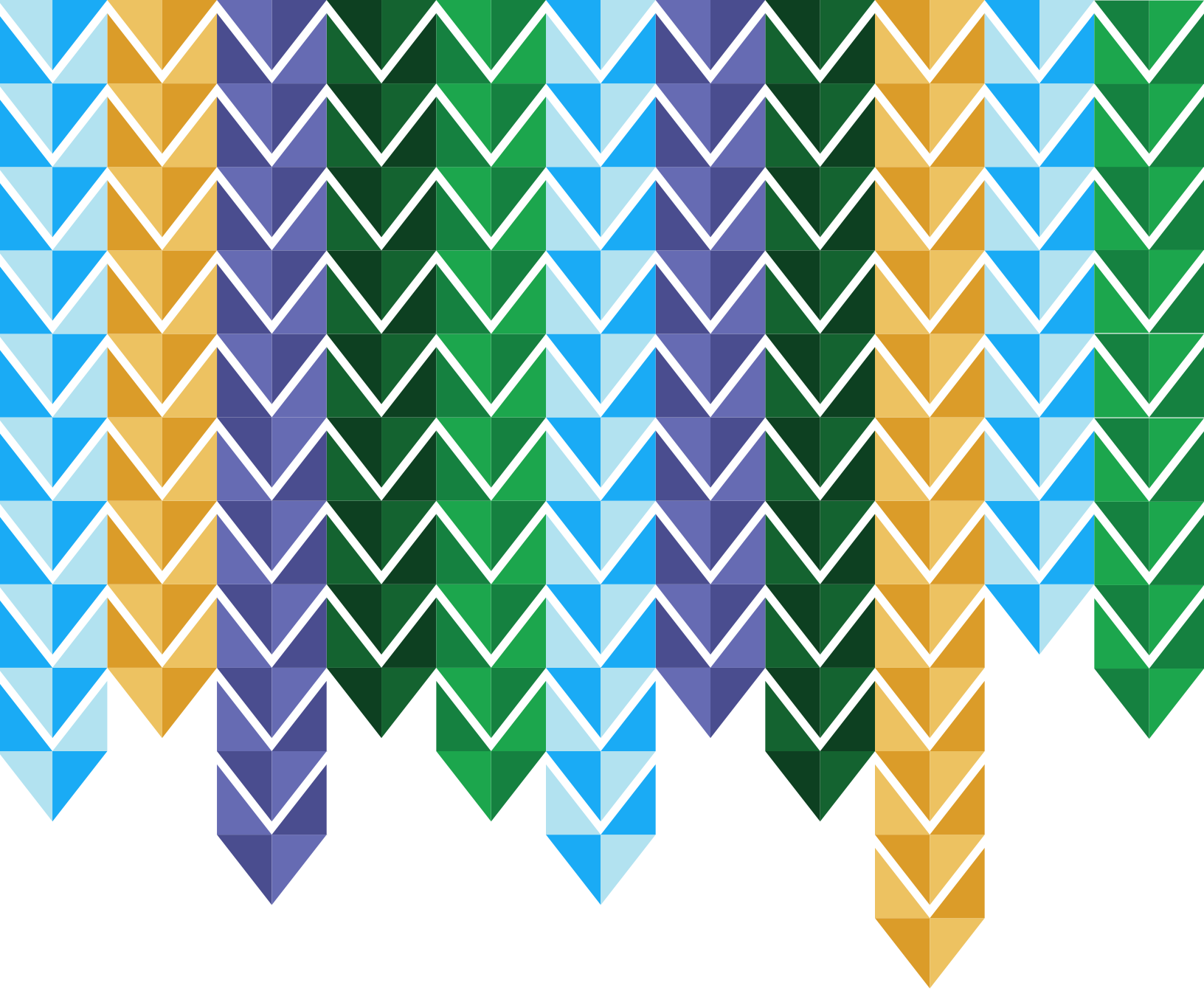## Katie Puckett
Mercer University

In my sophomore year, I was invited to join the Engineering Honors Program. Students participate in undergraduate research as part of the honors program, and I joined the research group of Dr. Sinjae Hyun. For the past three years, my research focused on the Touch 3D yearbook project for the Georgia Academy for the Blind. The Touch 3D yearbook is a yearbook with three-dimensional printed heads and braille nameplates for those students who are visually impaired. I worked with Dr. Hyun and other undergraduate researchers to design and build 30 Touch 3D yearbooks for the graduating seniors at the Georgia Academy for the Blind. Fellow Mercer undergraduate researcher Ji Kim and I, as project leaders, had the responsibility of helping guide various processes from beginning to end, from scanning students' faces to assembling the final yearbooks. I had the honor of co-presenting this project with Ji Kim and Dr. Hyun at the Gulf South Summit Conference in spring 2023, which was a unique experience as our group was one of the few with undergraduate student presenters.

Involvement in this project as a project leader was significant for me as an industrial management student, because it led to deeper understanding and hands-on experience with logistics, planning, documentation, and communication for the project. I learned about improving processes in an assembly, increasing efficiency, risk assessment, work standardization, and immediate problem-solving. Furthermore, I increased my knowledge of 3D scanning, printing, and modeling. When we presented the 3D Touch yearbooks to the students, I was able to see how my research contributions aided and impacted the students in this inclusive opportunity and experience.

Dr. Hyun also involved me in another amazing research project that focused on honoring Korean War veterans. Similar processes used in the Touch 3D yearbook project were applied to researching, designing, and building recognition plaques for families of veterans of the Korean War. I was given the privilege of handing the plaques to the respective veterans and families at the ceremony. It was the greatest honor to have the social responsibility of paying tribute to those who sacrificed for our country.

My experiences in undergraduate research have impacted me both as a student and in my future career. As a student, I was able to get to know my professors and understand the passions behind their research projects. Research was also vital to building a professional network, and it also guided decisions pertaining to my future career. Through this experience, I was able to see how my career opportunities ranged from being a traditional engineer to process improvement and project management. For every project, I had the privilege of sharing, presenting, and discussing my work, which aided in the further development of communication and interpersonal skills.